THE PETROLEUM INDUSTRY IN INDIANA IN 1906.

By W. S. Blatchley.

Definition of Petroleum.—Crude petroleum, or "rock oil," is a natural bitumen, composed mainly of the combustible elements, carbon and hydrogen. In its most common form it is a brownish-black, ill-smelling liquid, with a specific gravity of about .86. When kindled it burns readily with a bright flame and without leaving a residue. When exposed to the atmosphere it gives up slowly its volatile gases and is, in time, reduced to a thick, semi-solid, asphaltum-like mass. The name petroleum comes from two Latin words, *"petra,"* a rock, and *"oleum,"* oil, and in many localities it is known as "rock oil," or simply "oil."

Distribution of Petroleum.—Petroleum is widely distributed throughout the countries of the world, and is found in the rocks of almost every geological formation, from those of the old Archaean time up to the later members of the Tertiary Age. In some of the older countries, as India and Japan, it has been known to and used by man as a remedial agent for more than 2,500 years. For many centuries, however, its uses were few, its possibilities of furnishing valuable products by distillation not being known. With the advancement in the knowledge of chemistry came a better understanding of its component elements, and within the past quarter of a century it has come to be one of the great and necessary resources of an advanced civilization.

During the year 1905, the latest date for which statistics are available, the United States produced 134,717,580 barrels of petroleum, which brought, delivered into the pipe lines, $84,157,399. In the same year there was produced in the world 214,398,187 barrels. The United States, therefore, produced 62 per cent. of the world's output for the year, or 12 per cent. more than all the rest of the countries of the world.

Oil Fields of the United States.

The oil from the different parts of the United States varies much in character and grade, and comes from six main areas or oil fields.

The Appalachian Field.—This field comprises fully 50,000 square miles of territory in Pennsylvania, New York, West Virginia, South-

eastern Ohio, Tennessee and Kentucky. The most of the oil from it is known as Pennsylvania oil. It has a paraffine base, is considered best for making oil illuminating products and brings the highest price on the market, the average for the year 1905 being $1.39 per barrel.

The oil of the Appalachian field comes, for the most part, from porous sandstones and conglomerates which are imbedded in and underlain by great masses of shale. These sandstone beds occupy a position in the geological column of over 2,000 feet in thickness, extending from the Alleghany formation of the Carboniferous period to the base of the Devonian period.

From 1859, when the Pennsylvania oil was first produced in commercial quantities on Oil Creek, Pennsylvania, up to 1876, this field furnished all the oil produced in the United States. Between 1876 and 1885 other states produced less than 2 per cent. of the output, but with the discovery of oil in the Trenton rock at Findlay, Ohio, the percentage from the Appalachian field gradually decreased until, in 1905, it was only 21.8 per cent. of the total.

The Lima-Indiana Field.—In November, 1885, oil was first produced from the Trenton limestone of the Lower Silurian or Ordovician period, near Findlay, Ohio.

The territory yielding from the Trenton rock gradually expanded until it extends diagonally across Northwestern Ohio and into Indiana as far as Marion, Grant County. This territory is now known as the Lima-Indiana field. The oil from it ranks next to that from the Appalachian field in value, the average price in 1905 being 88 cents per barrel. Like the Pennsylvania oil, it possesses a paraffine base, but contains a certain percentage of sulphur not found in the former, and for that reason is more expensive to refine.

The output of the Lima-Indiana field in 1905 was 22,294,171 barrels, or 16.4 per cent. of the total produced in the United States. Of this Ohio produced 11,329,924 barrels and Indiana 10,964,247 barrels.

The Illinois Field.—In 1905 Illinois began for the first time to come into prominence as an oil-producing state. Prior to that time the only production in the State had been a lubricating oil, found in small quantity near Litchfield, Montgomery County, the total yield for fourteen years being less than 6,600 barrels.

In October, 1904, a well which had an initial production of 35 barrels was drilled near Oilfield, Clark County, in the southeastern portion of the state. This gave rise to extensive drilling in the vicinity of Oilfield and Casey, where more than 300 bores were sunk

in 1905, the output for that year being 181,084 barrels. During 1906 the field was extended southeast to the center of Lawrence County and the output was greatly increased in quantity.

The oil from the Illinois field is found in sandstones or limestones of the Upper and Lower Coal Measures. It is dark olive green in color and is "chiefly made up of members of the paraffine group and of the lighter members of that group." It is a lower grade oil than that of the Lima-Indiana field, and on December 1, 1906, was bringing 21 cents less per barrel on the market.

Near Princeton, in southwestern Indiana, a small area of oil territory has been developed, which, in 1906, yielded 103,843 barrels from about 130 wells. The oil is a dark, rather thick liquid, with a specific gravity of 31 degrees Beaumé, and comes from the Huron sandstone of the sub-Carboniferous age. Both geologically and geographically the Princeton field is closely related to that of Illinois and is therefore classified with it, although the production for 1905 was computed with that of the Lima-Indiana field.

The Mid-Continent Field.—This field comprises the oil producing territory of Missouri, Kansas and Oklahoma. It was first opened up in 1899 near Chanute, Kansas, and has extended rapidly in a southwest direction into Oklahoma.

The oil of the Mid-Continent field is produced "from the Pennsylvania series of the Carboniferous system. At the base of these rocks is the Mississippi limestone, with a thickness of from 300 to 400 feet. Directly above this are the Cherokee shales, with a thickness of from 400 to 500 feet, capped by the Fort Scott limestone. Above the Fort Scott limestone are alternating shales and limestones, extending to the surface. All of the shales, especially the Cherokee, contain sandstone beds in the form of lenses, some of which extend over a considerable area. These beds form the reservoir from which the oil is obtained. The most important sand so far discovered is near the base of the Cherokee shales. Two other horizons of pay exist, one near the top of the Cherokee shales and the other above the Fort Scott limestone."*

The oils of the Mid-Continent field differ very much in quality. The specific gravity runs from 18 to 40 degrees Beaumé. They are dark in color and carry some sulphur. The price in 1905 ranged, according to its specific gravity, from 25 to 80 cents per barrel. The output from this field for that year was 12,013,495 barrels, or 8.92 per cent. of the total produced in the United States.

The Gulf Field.—The oil producing territory of Texas and Louis-

*W. T. Griswold.—"The Production of Petroleum in 1905," page 41.

iana belongs to this field. An oil with a paraffine base had been produced at Corsicana, Texas, for a number of years before the low grade asphaltum oil was discovered at Beaumont. The output from Corsicana was, however, limited in quantity, and in 1905 formed only about one per cent of that from the Gulf field.

The Coastal Plain of Louisiana and Texas yields most of the oil from the Gulf field. The surface rocks of that plain consist mainly of unconsolidated clays, sands and marls, with some gravels and thin layers of hard limestone. These belong to the recent or Pleistocene geologic formations. Beneath these surface deposits are scattered limited areas of dolomitic limestone, very porous in character and with a hard, impervious top or cap. These form the reservoirs in which the oil is stored. They are very productive, but are soon exhausted when tapped. Five of these pools were discovered between 1901 and 1906, which yielded the enormous total of 104,066,198 barrels of petroleum.

The oils from the Coastal Plain have an asphaltum base or residue and a specific gravity of 18 to 28 degrees Beaumé. They are used mainly for fuel and in 1905 sold at from 27 to 37 cents per barrel. The output for that year from the Gulf field was 37,046,605 barrels, or 27.5 per cent. of the total production in the United States.

The California Field.—California produced petroleum in small quantity between 1865 and 1892. In the latter year a well was drilled in the city of Los Angeles, which yielded a small but steady flow of asphaltum oil, and from then on the output gradually grew until, in 1905, it was 33,427,473 barrels, or 24.8 per cent. of the total produced in the United States.

The oil of the California field is found in a number of porous beds of sandstone, all of which are saturated with petroleum and which, taken together, give a producing horizon many hundred feet in thickness, the wells varying in depth from 700 to 3,000 feet. Each bed yields an oil different in character from the others. All, however, have an asphaltum base and are used mainly as fuels, the price in 1905 averaging about 25 cents per barrel.

In addition to the six fields above mentioned, small quantities of oil were produced in Wyoming, Colorado and Michigan, a total of 387,792 barrels having been produced from these three states.

PRODUCTION AND VALUE.*

In the following table is given a statement of the total production of crude petroleum in the United States during the years 1904 and 1905, also the value of this production, with the average price per barrel of the petroleum from each state:

Total Quantity and Value of Crude Petroleum Produced in the United States and the Average Price Per Barrel in 1904 *and* 1905, *by States.*

State.	[Barrels.] 1904.			[Barrels.] 1905.		
	Production.	Value.	Average price per barrel.	Production.	Value.	Average price per barrel.
California	29,649,434	$8,265,434	$0.279	33,427,473	$8,201,846	$0.245
Colorado	501,763	578,035	1.152	376,238	337,606	.897
Illinois				181,084	116,561	.644
Indiana	11,339,124	12,235,674	1.079	10,964,247	9,404,909	.858
Indian Territory, Oklahoma, Kansas	1,366,748 / 4,250,779	5,447,622	.970	12,013,495	6,546,398	.545
Kentucky, Tennessee	998,284	984,938	.9866	1,217,337	943,211	.775
Louisiana	2,958,958	1,073,594	.3628	8,910,416	1,601,325	.180
Michigan, Missouri	2,572	4,769	1.854	3,100	3,320	1.071
New York	1,113,264	1,811,837	1.6275	1,117,582	1,557,630	1.394
Ohio	18,876,631	23,730,515	1.257	16,346,660	17,054,877	1.043
Pennsylvania	11,125,762	18,222,242	1.638	10,437,195	14,653,278	1.404
Texas	22,241,413	8,156,220	.367	28,136,189	7,552,262	.268
West Virginia	12,644,686	20,583,781	1.628	11,578,110	16,132,631	1.393
Wyoming	11,542	80,794	7.00	8,454	51,545	6.10
Total	117,080,960	$101,175,455	.864	134,717,580	$84,157,399	.625

USES OF PETROLEUM.

The average person has but little knowledge of the many uses to which crude petroleum is put, or of the variety of products made from it in the great refineries. The most important and best known of these products is, of course, the illuminating oil known as kerosene or "coal oil." This oil has become one of the greatest adjuncts of modern civilization; in fact, such a necessity of daily life that millions of inhabitants of this and other lands would find it difficult to do without. Besides kerosene, all the gasoline, benzine and naphtha of commerce come over as distillates from the crude petroleum. Among the solid products are vaseline, used so extensively as an external application, and paraffine, the candles of which have almost wholly superseded the old tallow "dip."

*From "The Production of Petroleum in 1905," by W. T. Griswold, in Mineral Resources of the U. S. for the year 1905.

Much paraffine is also used in making matches; as a preservative for eggs and various food stuffs; in laundry work as an auxiliary to soap, and for many other purposes. Rhigolene, a volatile product of crude petroleum, is a valuable anaesthetic, particularly for local application to produce cold.

Both petroleum products and crude pertoleum are much used in the manufacture of artificial gas. In the making of "air gas," or carbureted air, gasoline is needed, while for "oil gas" and carbureted water gas, crude petroleum is used, the liquid hydrocarbons of the oils being converted into permanent gas of high illuminating power. The crude petroleum is also often used for the enriching of coal gas, i. e., for making it of higher illuminating power.

Mineral oils from petroleum and the crude product itself are now almost wholly used for lubricating machinery, especially railway engines. As noted above, the poorer grades of crude petroleum, especially those with an asphaltum base, are extensively used as fuel.

In the words of the superintendent of one of the leading refineries of the country: "Practically nothing is now allowed to go to waste. Our by-products are really more valuable than the refined oil itself. Benzine and gasoline, which were formerly not considered by us, are now very valuable commodities. The coke which results from the burning of crude oil was formerly dumped into the river; now it is used in the manufacture of the carbons for electric lights, and we cannot get enough of it. The vapors arising from the oil are condensed and re-condensed and are added to our list of by-products. In fact, nothing is permitted to get away which can, in any manner, shape or form, be utilized, and this is ascertained by our chemists and inventive men.

"There is not a thing designed or invented that will aid us either in our manner of refining the oil or in effecting a saving so that we can utilize what was formerly wasted, that we do not have in our refineries. The changes that have taken place in the last ten or fifteen years are simply wonderful. Take refined oil, for instance. Many of our people can easily recall when it was almost as yellow as saffron; now it is as clear as crystal and has been refined to such a degree that not a drop of it need be wasted. Our oils are used in soaps, perfumes, liniments, vaseline and in so many different ways that I have neither the time nor the inclination to try to define their varied uses."

Origin of Petroleum.

Among geologists and scientists in general it is now commonly believed that petroleum has been derived from the decomposition of animal or vegetable bodies, or both. Many laboratory experiments and facts observed in nature tend to confirm this belief. For example, when the body of an animal or plant is distilled in a closed retort, or undergoes decay in the absence of air, certain gaseous and liquid products are always derived. Again, oily water frequently exudes from peat mosses; and marsh gas, the chief constituent of natural gas, bubbles up from every stagnant pool which contains rotting animal or vegetable matter at its bottom. There is, therefore, no need of far-fetched chemical theories to explain what is more or less a matter of common experience.

The Newberry Theory.—However, two distinct views prevail among geologists as to the manner in which the decomposition has been brought about. One of these views, first set forth by Prof. John S. Newberry, former State Geologist of Ohio, probably accounts best for the oil found in the sandstone strata of southwestern Indiana. Prof. Newberry claimed that the great beds of bituminous shales, such as the Huron, Genesee and Utica shales, have been the chief sources of petroleum—that the animal and plant remains in those beds have undergone a kind of distillation or secondary decomposition, resulting in petroleum which, by hydrostatic pressure, *has been carried to the rock strata in which it is now found.*

All shale beds are sedimentary in their origin, being composed of particles of clay which have been carried long distances and redeposited in water. Now it is well known that clay has a particular affinity for oily matter. Oily substances floating in muddy water have been found to attach themselves to suspended particles of clay and sink to the bottom and produce there a stratum rich in oil, which in time would be compressed by the newer overlying strata into shale. Much of the petroleum of the shale was doubtless thus derived from organic matter undergoing decomposition in other and remote strata.

At the time that the theory of Dr. Newberry was published, the large deposits of oil in the Trenton limestone rocks of Ohio and Indiana were unknown. His theory was based largely upon the Pennsylvania fields, and seems more clearly than any other to explain the origin of the petroleum there found. The Pennsylvania oil, like that of southwestern Indiana, occurs in sandstone strata which contain few, if any, organic remains, and could not, there-

fore, have furnished the original source of the oil. These sandstone strata lie, however, in close relation to the bituminous and other shales, and from their porous nature have served as reservoirs in which the oil, oozing from the shale, has passed and accumulated in large quantities.

The Hunt Theory.—The second theory was first promulgated by Dr. T. Sterry Hunt about 1862 and better than any other accounts for the oil in limestone rocks wherever found. Dr. Hunt asserted that petroleum has been formed from the remains of animals or plants in the *same rock strata now yielding the oil,* the decomposition having taken place under such conditions that the organism passed directly into petroleum, which has since remained in the rocks where it was formed.

Among the proofs of his theory, Dr. Hunt stated that in some cases petroleum is found filling the cavities of large fossil shells (*Orthoceratites*) in the Trenton limestone. "From some specimens nearly a pint of petroleum has been obtained." Again he cited the fact that a stratum of Niagara limestone near Chicago is so filled with petroleum that blocks of it, used in building, were discolored by the exudations which, mingled with dirt, formed a tarry coating upon the exposed surfaces.

The theory of Dr. Hunt was made known about 1862, long before oil was discovered in the limestone rocks of Ohio and Indiana. The facts gathered and observations made in the Trenton limestone field of these states have furnished much evidence in support of his theory; and it is now commonly believed by scientists that the oil found in limestone has been produced in the rock by the direct decomposition of organisms originally inhabiting the water in which the rock was deposited. Moreover, it is believed that, for the most part, these organisms were animals, since the limestone oil possesses more sulphur and nitrogen, is of a darker color, higher specific gravity and has a more rank and disagreeable odor than the "shale oil" produced in Pennsylvania, which probably owes its origin to the decomposition of plants in the manner set forth in the theory of Dr. Newberry, as given above.

Oil Fields of Indiana.

Petroleum in commercial quantities was first produced from the Trenton limestone in Indiana in 1889, in a well put down by the Northern Indiana Oil Company, on the D. A. Bryson farm near Keystone, Chester Township, Wells County. From that date until

January 1, 1905, the industry gradually grew until it became one of the greatest in the State. From 33,375 barrels, valued at $10,881 in 1889, the output increased to 11,331,340 barrels, valued at $12,176,880 in 1904.

In 1905 a decrease both in production and value began which has continued to the present time, the output falling to 10,969,308 barrels, valued at $9,305,473 in 1905, while in 1906 it decreased still further to 7,873,937 barrels, valued at $6,968,089. This decrease was due to several causes, chief among which was a decrease in price. While at no time during the two years did this fall below the profit-making limit of 80 cents, yet it was so much below the average prices of 1903 and 1904 that new developments were retarded. Much less wildcatting was therefore done during the two years, and the area added to the known productive territory of the State was very limited.

The discovery of oil in Illinois and the rapid development of the Mid-Continent field were also causes leading to the decrease in Indiana, as the great majority of operators left their Indiana holdings for these more promising new areas. The average oil operator is much like the gold prospector. He is usually eager to let the bird in hand escape when he sees or hears of a new one in the bush. No sooner is a new discovery heralded, even though hundreds of miles away, than he loses interest in his present holdings, however profitable they may be. There is a chance of securing valuable leases at a low figure, and of making in six months what it may take five years to accumulate by the older and surer method of bona fide production. So away he goes, and the older field, tried and tested as it is, is left to decline, while the newer takes on a boom oftentimes far beyond its real merit. In a territory as large as that of the Trenton rock field of Indiana, hundreds or even thousands of new bores must be drilled each year to offset the decline in output of the older wells. These new bores will not be sunk if the interests of the operators are elsewhere, or if the price of oil is so low as to reduce the profit of production to anything like a mere living.

There is an abundance of oil yet beneath the surface of Indiana, but until the price rises above the dollar mark the output will not reach the great volume it did in 1904, and it may never do so again.

Petroleum in commercial quantities has been found in three distinct geological formations in Indiana, viz.: The *Trenton limestone* of the Lower Silurian Age; the *Corniferous limestone* of the Devonian Age, and the *Huron sandstone* of the Sub-Carboniferous Age. It is, however, from the Trenton limestone that the great bulk

of the crude petroleum of the State is produced. Each of these formations will be taken up in order and its petroleum output treated.

Trenton Rock Petroleum.

Formation of the Trenton Limestone.—The Trenton limestone, one of the lower or older formations of the Lower Silurian period, underlies at variable depths the whole of Indiana. Along the Ohio River in Ohio and Switzerland counties it outcrops in a narrow strip. Like other limestones, it owes its origin mainly to the presence of minute organisms in the water in which it was first laid down. The animals from whose remains the oil of the Trenton limestone was, for the most part, derived, were probably very low forms—the polyps and bryozoans of the ancient Silurian seas. In untold numbers they existed, and the carbonate of lime which makes up 80 per cent. of the unmodified Trenton rock is largely the remains of their secretions and incrustations. Associated with these lower forms were myriads of higher ones—crinoids, brachiopods, trilobites, gastropods, and even fishes. The presence of such swarms of animal life made necessary the existence of an abundance of plants, since the plant must ever precede the animal and gather for the latter the energy, and form for it the food, the living protoplasm, necessary to its existence. These plants were mostly marine algæ, or seaweeds and fucoids, though doubtless many other forms existed of which no remains have been preserved in the rocks of that age.

The Trenton limestones were evidently formed in rather clear water, at moderate depths. Near the bottoms of these shallow seas great beds of calcareous sediment were gradually collected and were swept to and fro by the tides and currents. Rivers from the older Cambrian rocks brought down their eroded particles and added to the thickness of the ocean floor. Within these beds of sediment both plants and animals found a grave, their bodies in vast numbers being buried beneath the slowly accumulating deposits of centuries. Once buried in such deposits they did not decay, as do animals on land, because by the waters above and the calcareous ooze around them they were shut off from free oxygen, which is the chief agent in decay. Gradually this ooze or fine sediment was, by the agency of the sea water, cemented and consolidated into limestone. In this manner that great layer of Trenton rock, which underlies at variable depths the whole of Indiana, was formed. From it has been derived, directly or indirectly, more wealth than

from any other one formation either underlying or forming a portion of the surface of our State.

Formation of Utica Shale.—In time the waters of the ocean containing this vast stratum of Trenton limestone, with its enclosed accumulation of undecayed plants and animals, became turbid, and, instead of calcareous sediment, deposited mud and clayey sediment in thick beds on top of the limestone strata. These deposits of mud and silt were afterward, by later deposits, compressed into the fine-grained, impervious Utica shale, 100 to 300 feet in thickness, which thus effectually sealed the Trenton limestones, and so retained within them the oil and gas derived from their enclosed organic remains. This oil and its more volatile portion, the natural gas, was probably not formed in a short time, but is the result of a slow decomposition or destructive distillation, carried on through thousands of centuries. Accumulating in vast reservoirs, the more porous portions of the Trenton limestone or mother rock, it there remained until man came with his iron drill and furnished a vent through which it could rise. Then by combustion he caused it to yield up the stored energy, conserved since the sun's rays fell on the plants of the old Silurian seas.

Origin of Natural Gas.—From what has been said, it will be seen that both the natural gas and oil of the Trenton rocks had a common origin, viz.: the destructive distillation, carried on through thousands of years, of the plants and animals which existed in the Trenton period. As already noted, it is a well known fact that if wood, coal, or the body of any animal be placed in an air-tight retort and heated, a distillation will occur, and the object will be changed to gaseous, oily and solid matters. In the absence of heat and air a very long period of time will bring about the same results. By this is meant the process of "slow destructive distillation" above mentioned. The primary product of such distillation was probably a light oil, which in the course of ages has, by volatilization, yielded the gas, and has itself been condensed into the heavier petroleum. The gas being lighter and more volatile than the oil, gradually rose into the higher porous portions of the limestone.

If an open barrel be filled with crude petroleum from the Trenton limestone of Indiana and exposed for a single summer to the air, more than half of the contents will pass away in the form of a vapor, and a sticky, tar-like residue will remain. If by some means the escaping vapor could be collected and analyzed it would be found in the main to have the same composition as natural gas. In fact it would be natural gas and would burn as freely as a sam-

ple of that valuable fuel, collected in the ordinary way. In the depths of the rock the evaporation of the oil has been extremely slow and the amount has been limited both by the varying pressure of the overlying gas and the underlying water. There is little doubt, however, but that all the natural gas of the Trenton limestone has been so derived.

Distribution of Petroleum in the Trenton Limestone.

The majority of people who have never seen an oil field imagine that both petroleum and natural gas occur in immense caverns or hollow spaces in the rocks beneath the surface of the earth. They believe that great lakes or underground cavities of liquid oil or highly compressed gas exist, and that when tapped with a drill these yield in abundance the oil and gas of commerce. Such beliefs or imaginations are wholly wrong, for no large cavities or open spaces of any size occur in the rocks of oil or gas producing areas. All rocks are, however, porous; even shale of the closest grain will hold some liquid in the minute and microscopic cavities which it, in common with all rocks, contains. Now the oil and gas sands are simply very porous rocks which contain, not one great cavity, but millions upon millions of small or microscopic cavities, so that oil, gas, water or all three together, it may be, occupy these numerous little spaces, and thus saturate the rock just as water does a piece of cloth or a sponge. Not only Trenton limestones, but most other limestones, as well as many shales, have in the past produced petroleum in greater or less quantities. Distributed in minute proportions through the substances of the rocks, petroleum easily escapes notice, but when intelligently looked for its presence is revealed and, though the percentage is small, the aggregate is often vast.

If, for example, a stratum carries but one-tenth of one per cent. of petroleum and is 500 feet in thickness, it contains more than 2,500,000 barrels to the square mile. Indeed, so common is the occurrence of petroleum in stratified rocks that, wherever a close-grained shale occurs there is almost always a small accumulation of oil directly underneath it. The same thing is found where an impervious stratum of any other composition than shale occurs in the geological series. The larger the pores in an oil-bearing rock are, and the greater the volume they occupy in proportion to the volume of the rock mass, the greater will be the contained oil or gas supply, and this proportion, in fairly good producing sands

usually varies between one-fifth and one-tenth; that is, a cubic foot of rock would hold, say, six to twelve pints of oil, and of course would contain an equal volume of cavities for water or gas, should either of these substances be present instead of oil.

If petroleum has been thus generally formed throughout the Trenton limestone, why does not all of that formation yield it in somewhat equal amounts? Why is it that a bore that pierces the Trenton in one locality is a "dry hole," while another but a short distance away results in a "hundred-barrel well?" The answer to such questions lies in the fact that the formation of large accumulations of oil depends as much upon the presence of suitable strata to receive and retain them as upon an adequate source of supply. In the minutely diffused state in which the oil was originally formed it was wholly without value. Like all other forms of mineral wealth, it had to be concentrated into reservoirs, the so-called "pools" of the oil field, before it could be utilized by man. The general mass of the Trenton limestone is, however, too compact to permit the rapid passage of oil or gas through it or to form a suitable reservoir for the storage for large quantities of these fluids.

Conditions of Accumulation.

The thousands of bores put down to the Trenton limestone for oil and gas in both Ohio and Indiana have proven that four conditions are necessary before an accumulation and preservation of oil in commercial quantities can take place. If any one of these conditions is absent, a dry hole or salt water well will invariably result. These necessary conditions are:

1. A porous stratum of the Trenton rock to form a reservoir.
2. An impervious cover above the reservoir.
3. An arched or anticlinal structure of the rock in which the reservoir is located.
4. A pressure behind the oil to force it into the reservoir.

1. *The Porous Portions of Trenton Limestone.*—We have seen that the Trenton limestone is a sedimentary rock, i. e., one which was laid down in water, the bottom of the sea, ages ago. When first formed it was a nearly pure calcium carbonate or carbonate of lime. In the course of time certain areas of the sea bottom, covered with the incipient limestone, were slowly raised until they became higher than the others and formed shallow basins, lagoons or bays. Some of these raised portions covered very large areas. Others

were isolated or separated from the main area by a distance of one to 30 or more miles. The outline of all was irregular, with many indentations along the margins. In these more shallow portions of the Silurian seas the water in time became very briny and caused a chemical change in the rock. To the lime carbonate was added some chloride of magnesia from the brine, and a magnesia-lime carbonate called "dolomite" resulted. The following formula represents the chemical change which took place:

$$2\ CaCO_3 + MgCl_2 = Ca\ Mg\ (CO_3)_2 + Ca\ Cl_2$$

or two molecules of calcium carbonate + one molecule of chloride of magnesia = two molecules of dolomite + one molecule of calcium chloride.

Wherever the above change took place, which was only in the shallow, briny areas noted, the resulting dolomite was porous. This porous condition was due to the fact that the new crystals of dolomite were smaller than, and never entirely filled the spaces occupied by, the older crystals of lime carbonate. In other words each crystal of dolomite occupies less space than it did as a crystal of lime. Therefore, between each is a void or small pore which gives space for gas, oil or water, and allows the rapid passage of these substances through the changed limestone. *The larger areas of the Trenton limestone deposit beneath the present bounds of Indiana were either too impure to admit of a change into dolomite or the conditions of sea level were never such that the change took place; hence they are non-porous and barren of either oil or gas.*

Even in rich oil fields the porous dolomite has only been formed in a small proportion of the thickness of the Trenton rock. Usually two or more "pay streaks" or porous strata are found in the upper 70 feet of the Trenton. The upper one of these has a thickness of three to ten, or sometimes 15 feet, and usually occurs within 30 feet of the top of the Trenton. If the level of the Trenton is low at the point where the bore is put down, the upper streak is often lacking. The second porous stratum, usually the most productive, lies about 15 to 20 feet below the first and is separated from it by a bed of unchanged, non-porous limestone.

Until the year 1903 the shallow or upper pay streaks were thought to be confined entirely to the first hundred feet of the Trenton limestone. In that and subsequent years, however, developments have shown limited areas in Delaware, Randolph and southwestern Jay counties to contain another deeper pay streak lying from 270 to 310 feet below the top of the Trenton and sep-

arated from the upper pay by 200 or more feet of non-porous, non-productive limestone.

This alternation of dolomite and limestone strata is probably due to changes in the sea levels at the time the limestone was being transformed into dolomite. Wherever the Trenton limestone assumes its normal character and ceases to be dolomitic, it ceases also to be oil bearing. The change from an area containing porous rock into one wholly lacking it, is often abrupt. It is only the former which contains the oil, and there is no known method, except by drilling, of determining where the porous rock occurs.

2. *The Impervious Cover.*—In order to properly retain the accumulated petroleum the porous rock must be entirely covered with an impervious stratum, i. e., one through which neither oil nor its volatile gas will pass or can be forced by the enormous pressure behind it. Such a cover is usually a fine-grained shale, and wherever such a stratum covers a porous rock, petroleum in greater or less quantities is usually found. In the main Indiana oil field the Trenton rock is covered by a thickness of 200 or more feet of that dark brown, close-grained deposit known as the Utica shale, which possesses every quality of a typical impervious cover. The driller recognizes this stratum as soon as he strikes it by its color, its comparative freedom from fossils, and the ease with which it is drilled and mixed with water. No free oil is found in the Utica shale, though by distilling portions of it an amount equal to three per cent of the shale* has been obtained.

If a shale or other impervious cover did not intervene between the porous reservoir and the surface, the oil would long since have volatilized and passed off as escaping natural gas, leaving behind a tarry, asphaltum-like residue, which represents the solid portion. In many localities in the United States sandstones or limestones occur which are highly impregnated with such an asphalt substance. These deposits are found close to the surface with no shale above them. Had a shale been present, the strata containing the tarry substance would be oil-bearing. Thousands of dollars have been spent in drilling such localities in search of an oil which long since escaped in the form of gas.

When the oil-bearing stratum lies close to the surface, with only a thin shale above it, a heavy lubricating oil results. Such an oil, registering 20.8 degrees Beaumé, is found in Jasper County, Indiana, where it occurs in the Corniferous limestone at a depth of only 100 feet, beneath 45 to 55 feet of close-grained black shale.

*Dana, "Manual of Geology," 4th Ed., p. 522.

3. *The Anticlinal Structure.*—The surface of the Trenton limestone is not, as many people suppose, level, but, like the surface of the earth, is a series of alternating arches and depressions, or ridges and valleys. The arches or domes are like inverted troughs and vary much in width and area, as do also the depressions between them. Wherever gas and oil occur they will be found in a porous stratum in one of the arches or *anticlines,* as they are called. If a bore happens to be put down and strikes a depression or *syncline* between the arches, salt water will invariably be found. If both gas and oil are present in a certain area, and the bore strikes the flank or side of the arch, oil will result. If the bore strikes the crest or dome of the arch, gas will flow. The cause of this is simple, being due to the arrangement of the three fluids according to their relative weights. When the oil was first formed it was pushed or carried hither and thither by the heavier salt water behind it. Much of it was carried away by the water and lost, but wherever one of the porous areas existed in the side or top of an anticline, the oil was carried into it and there remained.

During the ages which have lapsed much of the oil was changed into a volatile gas, which rose into the higher porous portions of the anticlines or ridges of the Trenton limestone. As this gas accumulated, it pressed back the remaining oil into the sides or flanks of the arch. The oil being lighter than the water, rested upon the latter and prevented it from rising into the higher porous portions of the limestone. When a bore is put down and strikes gas the latter will flow until the quantity which is stored in the porous area of the anticline is exhausted, when the oil, if any be present on the flanks or lower portions of the porous stratum, will rise in the gas well. It may be that the oil has been carried by the salt water into the porous portions of another anticline, and that only salt water occurs beneath the gas. If this be true, the water will fill the porous reservoir as soon as the gas is exhausted.

The anticlines vary much in size, their domes running from scores of miles down to a half mile or less in width. The gas in the higher part of each anticline is, therefore, often shut off from that in a neighboring anticline by the intervening oil or water, or both. In the same way the oil in an anticline which contains oil only may be shut off from that in another anticline by the salt water filling all the porous portions of the syncline between. It often happens that a gas bore is put down which strikes the crest of a narrow anticline or raised portion of Trenton limestone which has not before been pierced. As a result the so-called rock-pressure of the

gas is at first high, but rapidly declines on account of the small size of the anticline. All the wider and higher anticlines in the main gas field in Indiana in which porous Trenton occurs, have been pierced many times, and the stored gaseous product has become almost exhausted.

In the Indiana field the result of a new bore can usually be foretold by the depth at which the top of Trenton rock is found. If it is from five to ten feet higher than the average in the nearby productive wells, the chances are that it will yield much gas and little oil. On the other hand, if the Trenton is struck ten to 15 feet lower than the average, the bore has pierced a trough or syncline, and a salt water well usually results. Sometimes, however, there are apparent exceptions. Of two wells in which the Trenton is found at the same depth, one will be a "gusher" and the other, but a short distance away, a "dry hole." The only explanation which can be given in such a case is that the latter has pierced a close grained or non-porous area of the Trenton, into which no fluid has found its way.

4. *The Pressure Behind the Oil.*—Whenever the drill pierces a stratum of porous rock containing oil, the latter is pushed upward by the so-called "rock pressure" behind it. Sometimes this pressure is so great that when the oil stratum is reached the boring tools are expelled from the drill hole, and the oil escapes in a fountain, rising high above the derrick, much of it being lost before the flow can be controlled. In most instances, even if the well proves to be one of small production, the oil is forced upward several hundred feet in the drill hole. As noted above, this rock pressure has, in the past, had much to do with the accumulation of oil in the porous reservoirs.

It is now almost universally admitted that the rock pressure in any oil field is nothing more or less than water pressure, as in artesian wells, the water entering the Trenton limestone at some point where the latter outcrops and so forming a head or source. Hence, the deeper the well, the greater the head of water and the higher the rock pressure. The porous rock contains a limited amount of oil, held in place by the overlying shale. The salt water is below this oil, ever pressing it upward into the vent furnished by the drill hole. As the supply of oil is gradually lessened, the water rises to fill the pores, and the rock pressure is lowered. The pressure does not tell us anything about the volume or amount of oil stored in the rock; but the rate of diminution of pressure furnishes an excellent index of the rapidity with which

that amount is being lessened. When the supply of oil is exhausted, as it naturally will be in time, there is no source from which it can be renewed. The salt water will rise and occupy the space which formerly held the oil and it will come to stay.

Salt Water.—Salt water also occurs in the Trenton rock in almost all portions of the Indiana field. Usually a difference of only six to ten feet in the elevation or depression of the surface of Trenton defines oil and salt water territory. If the well has been located over a syncline or trough, in the Trenton, salt water is apt to be found before the drilling has proceeded very far into that formation, and a well yielding only salt water usually results. If, however, the bore pierces the dome or flank of an anticline, either gas or oil will be struck, and the operator is usually careful to see that the drilling is stopped just before the level of the water producing rock is reached. In some cases, however, both water and oil are found together in the same stratum. Some of the best wells in the Indiana field are big salt water wells, pumping from 150 to 700, or even more, barrels of salt water, and 40 to 150 barrels of oil daily. It costs much more to operate a well of this kind, as it has to be pumped with a beam and, therefore, requires a separate power. Such wells are usually longer lived, as the salt water seems to renew the quantity of oil by bringing it in from quite an area of the porous stratum which the bore has pierced. Moreover, the salt water seems to keep the pores of the oil rock free from paraffine and other materials which have a tendency to clog them up, and a well producing four or five barrels of water a day in connection with the oil, is preferred by many operators to one that produces oil alone.

Quantity of Petroleum to the Acre.—If the amount of oil obtained from a productive sand be estimated at one gallon per cubic foot, and the sand is five feet in thickness, an acre (43.560 square feet) will yield about 5,000 barrels of forty-two gallons each. If the sand reservoirs be exceptionally thick or of very great porosity, the production will be much greater. It is estimated that Spindle Top Hill, in Texas, produced over 25,000,000 barrels from less than 200 acres. This, however, was a low-grade oil with an asphalt base. Such oils are usually more abundant in limited areas than those of higher grade.

By the ordinary processes of drilling and pumping it is impossible to get all the oil from any sand, even if a well be put down on every five acres. One-fourth or more will probably remain in the rock, held there by capillary attraction, which neither the accompanying gas nor the attraction of gravity can overcome.

The accompanying illustration (Fig. 1) will probably lead to a better understanding of the above mentioned facts regarding the accumulation and preservation of petroleum in the Trenton rock fields of Indiana.

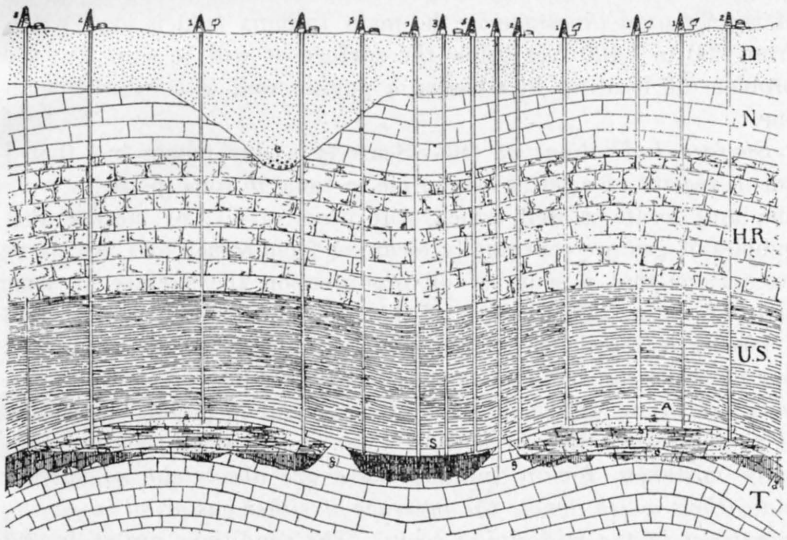


Fig 1 D., Drift. N., Niagara limestone. H. R., Hudson River limestone. U. S., Utica shale. T., Trenton limestone. A., anticline. S., syncline. a to b, gas bearing stratum. b to c, oil bearing stratum. c to d, water bearing stratum of porous rock. e, preglacial channel through Niagara limestone. f., non-porous Trenton limestone.

Wells, Nos. 1 produce gas; Nos. 2, oil; Nos. 3, salt water; No. 4, dry hole; Nos. 5, oil and salt water.

Pools not Necessarily Connected.—A fallacy which is held by many would-be operators in the Indiana field is, that oil fields or pools run in lines, and that one field is connected with all others, the oil flowing from one to the other through a continuous strip of porous rock. This may in part be true in the Pennsylvania and West Virginia oil regions, but it is wholly untrue in the Trenton limestone area of Ohio and Indiana. While all the so-called "pools" of that area are found in the anticlines in the Trenton formation, they are not necessarily connected, nor do the anticlines run in straight lines. From what has been said about the origin of the porous areas of the Trenton limestone, it will be seen that a pool may be of any shape, and may lie in any direction from any other pool. Its boundaries may be straight or sinuous; its area one square yard or one thousand square miles. If the conditions necessary for the storing of petroleum, namely, a porous reservoir, located in the flank or dome of an anticline of the Trenton lime-

stone, with an impervious cover above it and a water pressure below it, have been present in the past, the oil will very likely be found, whatever the shape, size or relative location as to other similar reservoirs. If any one of these conditions is lacking or has been lacking, the bore is sure to be a dry hole. Inasmuch as the top of the Trenton limestone in the main Indiana field is everywhere from 700 to 1,100 feet below the surface, it will be seen that the problem of locating in advance a paying well is a most difficult one.

Surface Indications of Oil.—Scarcely a day passes but that I am in receipt of a letter asking me to come to some point in Indiana and locate a well which will produce oil; or stating that bubbles of gas are continually escaping from some pond, spring or stream; or that a scum of oil occurs upon the surface of some body of water. The writers of these letters evidently believe that I possess a knowledge of the surface which will indicate where paying wells can be located, or that such bubbles or scum are certain indications of the presence of gas or oil in paying quantities. If they possess either or both of these suppositions they are woefully mistaken, for in Indiana *there are absolutely no surface indications which denote the presence of either gas or oil in paying quantities in the underlying rocks.* The conditions are such that no man on earth can, with certainty, locate in advance a productive well in any portion of the Indiana field. Gas and oil are found in commercial quantities in the State only at depths ranging from 700 to 1,600 feet below the surface.* Between the formations containing the gas and oil, namely, the Trenton and Corniferous limestones and the Huron sandstone and the surface, there are always one or more close grained shales, 50 to 300 feet in thickness. These shales are wholly impervious to both gas and oil; i. e., no particle of either of these fluids can find its way through them. In fact, such a shale is an absolute necessity to the presence of a commercial body of either gas or oil, else both of these would have long since found their way upward into the atmosphere. The bubbles of gas, noted as escaping from water, are in almost every instance marsh gas, which is formed by decaying organic matter at the bottom of the water, or in some deposit of carbonaceous material near by. The oil has exuded in minute quantities from some shale, clay, limestone or sandstone, as all such rocks contain

*The Jasper County field is an exception to this, a heavy lubricating oil being there found in the Corniferous limestone at 100 to 120 feet below the surface. However, a shale, impervious to the oil, lies between it and the surface.

some oil. But a drop or two is necessary to form many square feet of film or scum over the surface of a spring or pool. In many instances the supposed oil on the surface of a spring is not oil, but a brownish, yellow precipitate of iron oxide.

Again, as already noted, the oil producing rocks in Indiana follow no definite direction, as in some other states. There is no northwest-southeast, or northeast-southwest axis or trend of 30, 45 or any number of degrees which the intelligent operator can follow and sink a productive bore 99 times out of a hundred. His operations in the State must always have an element of chance connected with them. If he keeps well within the bounds of productive territory his chances of failure are much fewer than if wildcatting on the outside of such limits. But on the best area of known productive territory an occasional bore will come in dry.

One fallacy believed in by many would-be and some old operators is that the main Trenton rock field in Indiana is connected in some way with the ones at Terre Haute and Princeton. Any person with the slightest knowledge of geology should know that this is impossible. The Trenton rock belongs to the Lower Silurian period and was in existence millions of years before the Corniferous limestone at Terre Haute or the Huron sandstone at Princeton were formed. Neither is there any connection between the fields in Jasper County, Indiana, and those about Casey and Robinson, Illinois, the oil in each of these fields being in wholly different geological horizons. The belief in some kind of a northeast-southwest line or trend is probably largely responsible for the erroneous opinions held concerning the connection of these widely separated fields.

Condemned and Abandoned Territory.—During the first few years of drilling for oil in Indiana much territory was needlessly condemned by isolated bores which were dry or very small producers. The average operator then, as now, was in search of "gushers" or big wells, and turned down in disgust any territory where wells came in for less than ten barrels. With but little knowledge of the conditions governing the accumulation of oil, it was thought that a dry hole condemned a square mile or more of the area about it. Experience, gained by the sinking of thousands of bores has, however, proven that "one well is a test for but one location;" that is, for an area of but a few acres about the bore. As a result, much of the condemned territory has been redrilled and, in most instances, fair to good producing wells have been

developed where at one time it was thought that no oil existed. Examples of such territory are mentioned on a later page under the matter descriptive of new development in Bear Creek Township, Jay County, where some of the best wells drilled in 1906 were completed.

There is little doubt but that hundreds of producing wells could be drilled about the margins of the present productive area shown on the accompanying map of the main Indiana field, in territory which has been condemned or abandoned. The pools containing the porous reservoirs in which the oil is stored are so irregular in size and outline that no one can locate their boundaries. Oil doubtless exists beneath many localities in the State which never have been or never will be tested. Wildcat bores sunk at a venture will doubtless disclose the presence of many pools now unknown, but the majority of such bores will doubtless prove barren on account of the absence of some one of the necessary conditions to oil accumulation above enumerated.

From what has been written it will be seen that the operator in the Indiana oil field is taking chances whenever and wherever he sinks a bore. He has no way of knowing beforehand what the results will be. He may pierce the center of a reservoir and get a 300-barrel well; he may strike near its outer rim and get a ten-barrel well; he may miss it altogether and get a dry hole. One thing he can rely upon if he strikes a productive well, and that is that he is drawing upon a stored product which is not now being formed in the rock from which it is drawn and that, therefore, he must eventually exhaust the stock of oil from the immediate vicinity of his bore.

Need of Accurate Surface Levels.—In order to properly develop any oil producing area and reduce the number of dry holes to a minimum, the trend, width and dip of the anticlines and synclines in the top of the oil producing stratum should be ascertained by an accurate determination of the surface levels between a number of wells. Where a bore for petroleum has resulted in a good producing well, the level of the surface of the oil bearing rock above or below tide should be carefully ascertained. This can be done only by running a transit level from the nearest point where the surface is known, usually on a railway, to the site of the bore. By subtracting the surface level of the bore from the depth at which the oil bearing stratum is first struck, the surface of the latter in terms of sea level will be obtained, provided it is below tide. Where the oil bearing rock occurs above tide, the depth of it

will be less than the sea level elevation of the bore, and should be subtracted accordingly.

The location of the first half-dozen or so wells in any area a mile or two square must of necessity be a matter of guess work, but if the surface level of the top of the sand in each bore, productive or dry, be carefully ascertained, the trend of the anticline and the approximate limits of the field or pool can be soon determined. Too much guess work is carried on concerning the surface level of the spot on which the well is located. In a broken country it is difficult for any man to guess approximately the relative levels of two points a quarter of a mile apart, and the new level should always be ascertained with instruments. The surface level of the bore has nothing to do with the absolute height or surface level of the productive sand, or the absence or presence of the petroleum, but it has a great deal to do with the accurate determination of the surface level of the sand, and therefore with the location of future wells. If a few thousand dollars had been spent in Indiana in past days in the careful determination of surface levels, it would have saved a few hundred thousand which have been sunk in dry holes.

Many Bores too Shallow.—Investigations carried on during recent years in the central-southern and western portions of Indiana, and records of many bores which have been sunk in these regions. have led me to believe that the majority of the early drill holes sunk in search of Trenton limestone failed to reach that formation. This failure to sink the bores deep enough was due to several causes, chief among which was the great difference in the strata overlying the Trenton in those portions of the State from those overlying the same formation in the main gas and oil producing areas. In the latter areas the Niagara limestone of the Upper Silurian age and the Hudson River limestones and the Utica shale of the Lower Silurian, are the only formations to be pierced by the drill between the drift or surface and the oil and gas bearing Trenton. In the central-southern and western portions, especially the latter, a number of formations which are wholly absent in the main gas and oil field, intervene between the surface and the top of the Niagara limestone. The drillers employed during the gas and oil excitement of 1887 to 1895 to sink the bores in these regions were, for the most part, from the gas fields. Their knowledge of geology was small, and in many instances, after passing through a shale which resembled the Utica, and which they doubtless thought was that formation, they called the underlying rock "Trenton lime-

stone,'' and soon abandoned the bore as barren. The shales which they had pierced may have been any one of a half-dozen carboniferous shales or, what is more likely, the black Genesee shale, no one of which occurs in the main gas field.

Again, strong flowing veins of salt water were struck in a number of the bores, and the local companies, whose members were paying for the drilling, became alarmed at the extra cost necessary to case off such water, and often abandoned the bore before reaching Trenton. In a number of instances in the southwestern counties, the Corniferous limestones and Huron sandstones which in places, as Terre Haute, Birdseye, Loogootee, Princeton, etc., have proven oil and gas bearing, were not even reached, though they lie 900 to 1,400 feet above the Trenton. Wherever a bore was thus abandoned without reaching Trenton or some other oil-bearing formation, all the money spent was wholly wasted, there being neither negative nor positive results. Moreover, much territory was condemned as non-productive without being given a fair test.

The foregoing statements are not made because I believe that gas or oil in paying quantities will eventually be found in the Trenton limestone in southern and western Indiana, for I have no reasons for such a belief. Neither have I reasons for believing the contrary. If the earlier bores had of a certainty reached Trenton and proven barren, then negative evidence would have been available. The one fact which I do wish to impress upon the citizens of the regions mentioned is that much of their territory has not been properly tested.

Another and more important reason for the statement is to induce companies who start future bores to Trenton to see to it that nothing stops the drilling before Trenton limestone is reached, or rather, before that formation has been pierced at least 300 feet. Beyond that depth there is little possibility of finding either gas or oil. A contracting driller of experience can easily and without great expense, case off any salt water which may give him trouble. An accurate record of the thickness of each formation passed through, together with a small vial of the drillings of each, will aid much in determining the horizon which the drill is piercing at any depth, and such record and samples should always be kept.

THE MAIN TRENTON ROCK OIL FIELD OF INDIANA.

The main area of Indiana at present producing Trenton rock petroleum in commercial quantities occupies a portion of nine counties northeast of the center of the State, viz., Adams, Wells, Huntington, Grant, Blackford, Jay, Madison, Delaware and Randolph. As shown on the accompanying map, it may be said to comprise about 1,280 square miles, being included within an oblong strip of territory approximately 50 miles long by 24 miles wide, extending from the Ohio-Indiana state line westward to the eastern limits of Liberty township, Grant County, and from Warren, Huntington County, south to Hartford City, Blackford County, and an irregular area of 80 or more square miles south and southeast in Delaware and Randolph counties. This territory comprises all or a part of each of the following civil townships: Blue Creek, Jefferson, Wabash and Hartford, Adams County; Nottingham, Chester, Jackson, Liberty and Harrison, Wells County; Salamonie, Jefferson and Wayne, Huntington County; Van Buren, Washington, Franklin, Center, Monroe, Mills, Jefferson, Fairmount and Liberty, Grant County; Washington, Harrison and Licking, Blackford County; Penn, Jackson, Bear Creek, Wabash, Knox and Richland, Jay County; Monroe, Greene and Stony Creek, Randolph County; Niles, Washington, Hamilton, Center and Liberty, Delaware County; Van Buren, Boone and Monroe, Madison County. Of these the townships mentioned in Randolph and Delaware counties and Richland township, Jay County, lie some distance outside the main field, but may in the future be connected with it by the finding of productive territory in the intervening area. Aside from this main field, Trenton rock oil is produced in limited commercial quantities in small areas in Wabash, Miami, Hamilton and Marion counties.

The surface of the main area now yielding Trenton rock oil in Indiana was originally one great plain, with only occasional small undulations to break its monotony. This plain has been eroded in many places by the streams which in the past have been much larger than at present. Wherever bluffs or hills are found they are but the results of such erosion. But few outcrops of rock occur within the oil field, and they are found only along the streams, where the water has eroded deep channels through the drift and boulder clay, everywhere covering the oil territory to a depth of from 50 to 250 feet. These outcrops belong to the Niagara group of the Upper Silurian period.

The formations passed through by the drill in all parts of the field before the Trenton limestone or productive sand is reached are, therefore, as follows: Drift, Niagara limestone, Hudson River limestone, Utica shale. In the eastern half of the field an average section showing the thickness of each formation passed through would be about as follows:

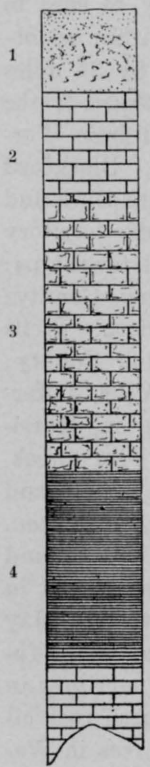


Fig 2.
Eastern.

		Feet.
1.	Drift	125
2.	Niagara limestone	150
3.	Hudson River limestone	425
4.	Utica shale	300

In the western portion of the field the average bore shows:

		Feet.
1.	Drift	175
2.	Niagara limestone	325
3.	Hudson River limestone	310
4.	Utica shale	200

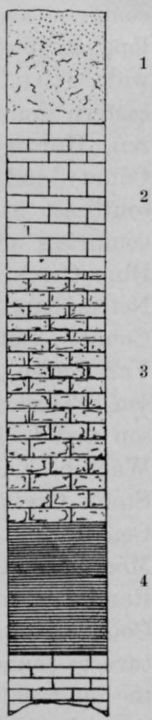


Fig. 3.
Western.

Throughout the Indiana field an eight or ten-inch drive pipe is forced down through the drift to the Niagara limestone. The fresh water usually found in the Niagara is cased off by an iron tube 5⅝ or 6¼ inches in diameter, which reaches from the surface to the soft blue Hudson River limestone underlying the Niagara. This second limestone and the Utica shale beneath it contain no water. The Trenton is everywhere overlain with the soft, dark colored Utica shale which forms an impervious cover through which neither gas nor oil can escape. From the bottom of this shale the drill passes at once into the hard crust of the Trenton limestone.

As already noted, two or three "pay streaks" or porous layers are usually found in the Trenton, and it is only in them that oil occurs. The first or upper layer is usually 15 to 25 feet below the top of the Trenton; the second, where present, is 15 to 25 feet below the bottom of the first. In limited areas in Delaware, Randolph and Jay counties a deeper pay streak occurs at 270 to 310 feet below the surface.

In the well records given on subsequent pages the length of the drive pipe represents the thickness of the drift. By subtracting the number of feet of drive pipe from the number of feet of the casing the thickness of the Niagara limestone may be ascertained. The distance from the bottom of the casing to the top of Trenton represents the combined thicknesses of Hudson River limestones and shales and Utica shale. The driller calls both of these formations "shale," usually distinguishing them by the terms "blue" and "brown" or "black." The average operator and driller pays little attention to the names of the rock formations passed through, but can tell to an inch how much iron has been used in the bore. The records as given are practically the only ones kept in the field.

The Oil Map.—The accompanying map of the main Indiana oil field is the fourth issued by this Department in the last ten years. The first, showing the exact area tested up to January first, 1897, was issued in the 1896 (21st) report of this Department. The field then embraced but 400 square miles. This map, enlarged and modified so as to show the field as it was on January 1, 1901, was published in the 1900 (25th) report. The area had then increased to 900 square miles. The third map brought the field up to January 1, 1904, and embodied an area of 1,350 square miles, not including a large portion of Madison, Delaware and Randolph counties, which were added to embrace the Parker-Selma pools. The fourth and present map shows the field as it was on January 1, 1907. From it we learn that the productive area has been decreased, several townships which showed a limited production in 1903, now being outside the bounds of productive territory. For the first time, the *abandoned territory*, or that formerly under lease and producing oil, but now having the iron in the wells pulled and the leases allowed to lapse, is shown.

The new productive territory shown on the present map is mostly in Delaware, Randolph and Jay counties. In the first two, the deep pay developments of 1904 and 1905 added an area of some 70 square miles, while in Jay County, several square miles in Bear

Creek township were added in 1905 and 1906. However, the amount of old territory abandoned since the former map was issued, far exceeds that added by the bringing in of new wells on the outside.

GRANT COUNTY,

in which the most westward extension of the main Indiana Trenton rock oil field is located, lies west of the counties of Wells and Blackford and south of Huntington and Wabash counties. It comprises an area of 416 square miles, the surface of which is, for the most part, level or slightly undulating, though in the vicinity of the Mississinewa River many hills, due to erosion and from 50 to 100 feet above the level of the river bed, are found.

The Mississinewa enters the county near its southeastern corner and, flowing in a northwesterly direction, leaves it on the northern border, six miles east of the northwestern corner. In the early history of the county it was navigable for flatboats, which were loaded at Marion and transported via the Wabash and Ohio rivers, to New Orleans. It and its tributaries drain the greater part of the county; but the western tier of townships is drained by Pipe and Grassy creeks, and the northeastern corner by Black Creek, a tributary of the Salamonie River.

The soils of the county are mostly of drift origin, and for the most part are fertile, though in some localities a lack of necessary drainage has rendered their tillage unprofitable.

The transportation facilities of the county are excellent, the T., St. L. & W. (Clover Leaf), the Michigan Division of the Big Four, the P. C. C. & St. L. and the C. C. & L. railways passing entirely through it, and having a common junction point at Marion, the county seat. Besides these, the C. I. & E. crosses its southwestern fourth, while the Union Traction Company's lines operate between Marion, Anderson and Indianapolis and Marion and Wabash. The Marion, Bluffton and Eastern traction line also runs to the eastward. The population of the county in 1900 was 54,693, as against 31,493 in 1890, while that of Marion was 17,337, as against 8,769. This notable increase was due almost wholly, either directly or indirectly, to the gas and petroleum developments brought about in the county during the decade in question.

The elevations in feet above tide of the principal railway stations in the county are as follows: Fairmount, 880; Fox, 817; Herbst, 851; Jonesboro, 848; Landessville, 864; Marion, 811-814;

Miers, 823; Roseburg, 845; Sims, 857; Swayzee, 859; Sweetsers, 844; Upland, 939; Van Buren, 840.

In 1902 and 1903, Grant County became the banner oil producing county in the State, easily outranking Wells, which had formerly held the lead in production. In 1904 and 1905 it was outranked by Delaware County on account of the discovery of oil in the deep pay east of Muncie. While the number of bores sunk in 1906 was less than in 1905, the production held up better than in Delaware, and the two counties are now very close together, with Grant once again in the lead.

Washington Township (25 N., 8 E.)—This area of 36 square miles north and northeast of Marion was probably as active in new work in 1906 as any section of equal area in the main field. Most of the new wells were, however, of light caliber, starting at five to 30 barrels. In six months the majority of such wells in the township drop to three to five barrels, and hold up to this production for a long time.

In the northern tier of sections Nos. 1 to 4 may be ranked as shown on the map, while 5 and 6 have produced gas only. The best bore of the year in this tier was on the Callentine lease in the northeast quarter of 3 and started at 30 barrels.

In the second tier of sections, Nos. 7, 8 and 9 are mostly gas bearing, there being only a few light oil pumpers on the Dickens tract in the southeast quarter of 8. Oil is beginning to show in a number of the wells. On leases operated in adjoining sections, as Nos. 10, 15 and 16, much gas is wasted by burning an excess in the boilers, the flames often running out of the stack for 30 or more feet. Section 10 is mostly oil territory, but the yield is light. The south half of 11 is among the best in the township, a half dozen or more wells on the Creviston and Williams farms starting during the year at 20 to 50 barrels. Section 12 is also above the average, the old wells making two to two and a half barrels each per day.

Sections 13 and 14 both comprise fair territory, none of the new wells starting above 35 barrels. The south half of 15 and the north half of 16 are also above the average. The Lewis Smith tract of 200 acres in the west half of 16 is yet untested, as the owner has so far refused to lease.

Bores No. 1 on the N. M. Bradford, and No. 1 on the Ira Bradford, in the north half of the southeast quarter of 16, and No. 11 on the J. T. Bradford, in the southwest quarter of 16, had the following records:

	No. 1, N. M. B. Feet.	No. 2, I. B. Feet.	No. 11 J. T. B. Feet.
Drive pipe	285	256	341
Casing	509	499	442
Top of Trenton	995	996	994
Gas	1020	1020	1020
Best oil	1040	1030	1055
Total depth	1071	1071	1094
Initial production, barrels	25	60	15

The larger portion of sections 17 and 18 belongs to D. Cretsinger, and was under lease by the Pittsburgh-Columbia Oil & Gas Company. Three bores were sunk on the west half of the southeast quarter of 18, but yielded only gas and a showing of oil. They were therefore abandoned and the leases cancelled. Section 19 is untested. The Wm. Bocock farm in the northeast quarter of 20, had on it two light producers which have been abandoned. The only productive wells are now on the Motter tracts in the south half of the section. All of 21 is now light producing territory. The Sears lease in the east half of the northeast quarter of 22 has been abandoned, but the remainder of the north half of the section remains fair, as does also the greater part of section 23, while the new wells in 24 are only average producers.

The north half of 25 is mostly light territory while the south half has only gas and dry holes to its credit. However, deep drives have prevented much drilling, the drift running 440 or more feet in thickness. The greater part of 26 is fair territory, the northern third of the section grading above the rest. The southeast quarter is in the deep drive and is, as yet, non-productive. Most of section 27 is now light territory, except the west half of the northwest quarter which has been abandoned. The Love tract on the southeast quarter has been a big producer in the past. Section 28 is at present all fairly productive, but a number of the best wells are only a year or two old, while the new ones of the year were mostly light. The northeast quarter of 29 was abandoned after a dry hole or two had been bored on it but was afterward re-leased and is now the best portion of the section.

Sections 30 and 31 and the greater part of 32 are as yet non-productive. The northeast quarter of 32 and the south half of 33 have each yielded a few light wells which have been pulled. The northeast quarter of 34 is the best part of that section. The Corey lease of 100 acres in the center of the south half has been abandoned. The remainder is for the most part light.

The greater part of both sections 35 and 36 has been abandoned,

the bores sunk having resulted in light wells or dry holes. The Allen farm in the northwest quarter of 35 is a fair producer, while all other pumping wells are light.

It will be seen that Washington township is mostly light to fair producing territory. Almost all of its area east of the Huntington-Marion pike has been tested. All recent wells have had a small initial production, but the older drilled portion holds up well, and the township will yield a good output of oil for several years.

Van Buren Township (25 N., 9 E.)—This township, in the northeastern corner of Grant County, comprises one of the oldest and best known oil producing districts of the State. The first oil well in Grant County was drilled in the outskirts of the town of Van Buren in 1890. From that time until the present the drill has been kept almost constantly going in Van Buren township, and its area has been pretty thoroughly gone over. The results have been above the average, the township ranking with Nottingham and Jackson, of Wells County, as a reliable producer. While most of its territory was classed as good on the former map, many of the leases had at that time been drilled out; i. e., had bores on all the locations. The production has naturally fallen until such territory must now be classed as fair or light. But few big producers have been finished in recent years, but the yield is yet large on account of the great number of wells. The present rank of most of the sections is shown on the accompanying map and only new developments of special interest are herewith noted.

Section 2 has increased in output and may be regarded as fair average territory. A record of No. 4, finished November 7, 1906, on the M. R. Green tract in the northeast quarter of the southwest quarter showed:

	Feet.
Drive pipe	174
Casing	460
Top of Trenton	992
Gas	1007
Oil	1020
Total depth	1046
Initial output, barrels	20

A deep pay well was sunk in 1904 on the Wisehart lease in the northeast quarter of section 2. This bore penetrated the Trenton limestone 347 feet, but found no oil except in the first pay.

Several wells starting at 40 to 60 barrels were drilled in sections 5 and 7 during the year. Of these, No. 22, on the A. Pulley tract,

finished August 18, in the southwest quarter of 7, had the following record:

	Feet.
Drive pipe	156
Casing	439
Top of Trenton	1003
Gas	1012
First oil	1018
Best oil	1038
Total depth	1085
Initial output, barrels	65

A dry hole was drilled on the Kirkpatrick lease in section 15 where 14 producing wells were located. A bore on a town lot in Van Buren, finished in July, in territory once abandoned, started at eight barrels.

Section 32, marked light on the old map, is now fair to good territory. No. 17, finished in September on the Hayes farm in the southwest quarter, showed the following record:

	Feet.
Drive pipe	412
Casing	441
Top of Trenton	972
Gas	987
Oil	1005
Total depth	1032
Initial production, barrels	30

Monroe Township (24 N., 9 E.)—The north half of this township has in recent years produced considerable oil, but the territory has been very spotted, dry holes and gas wells alternating on many of the sections with fair to light oil producers. A number of the first leases developed have been abandoned. In the south half, much of the area is as yet untested on account of the presence of gas. No railway passes through the township and in winter and spring but little hauling of supplies can be done over the mud roads.

The first producing well in the township was drilled by Joshua Strange in October, 1895. It was on the southwest quarter of section 10 and the oil rose 600 feet in the bore, the top of Trenton having been struck at a depth of 987 feet. From that time to the present drilling has continued and in 1906 quite a number of new bores were sunk, the most of which came in as light to fair producers.

The five new bores in sections 1 and 2 were either light or dry. Two of these, on the Eikenberry farm in the west half of 1, came in as an eight barrel producer and a dry hole. The former

producing wells in section 3 have been abandoned. The only production in sections 4 and 5 is in the north halves. On the A. Haines farm in the northwest quarter of 7 there are 18 bores, two of which came in during the year as 5 and 12-barrel producers.

On the Hockett farm in the northeast of section 6 two old gas wells were drilled deeper and put to pumping but only yielded one-half barrel each and were abandoned. The west half of the section is still fair territory. Some light producers have been drilled on the south half of 7, while those on the north half, formerly productive, have been pulled. Section 8 is undrilled, while the productive leases formerly in 9 have been abandoned. The north half of 10 is also undrilled, the northeast quarter never having been leased. The south half contains several light wells. Sections 11 and 12 still continue lightly productive, except the southwest quarters of each which have been abandoned. A bore on the Hoover lease in the northwest of 12 was barren. Four or five bores were sunk on section 13 during the year, one of which was dry, while the rest started at less than 20 barrels. The southeast and northwest quarters of 14 are light; the remainder undrilled.

Section 15, where some of the oldest wells in the township are located, is mostly light; many of the wells doing less than a barrel a day. Only gas is produced in 16, while the wells in 17, formerly productive, have been pulled.

All of 18 except the northeast quarter is productive but light, the new bores starting at 10 to 15 barrels. There is no production in sections 19 to 22, the few wells formerly yielding having been abandoned. There are a few light wells on the northeast of 23 and the north half of 24, while all of those in 25 are of the same kind. Sections 26 to 33 are either undrilled or produce gas only. A number of light to fair wells were sunk on the south half of 34 during the year; the best being on the Moore lease in the southwest corner.

There are several light producers on the Hogston, Myers and Hinicker leases in the south half of 35 and also a few in the southeast of 36. A dry hole on the J. Palmer in the southwest of 36, finished in September, had the following record:

	Feet.
Drive pipe	227
Casing	403
Top of Trenton	995
Gas	1030
Water	1049
Total depth	1077

Centre Township (Sections 1 to 24, 24 N., 8 E.)—This township, in which the city of Marion is mostly located, has been pretty thoroughly drilled, and its area has proven, for the most part, productive. A large portion of the older tested territory has, however, been abandoned and the later wells are mostly light producers.

But one bore was sunk in section 1 during the year. It was on the Mang farm in the southeast corner and started at only 10 barrels. All the section is light territory, as is also the east half of 2, the west half of the latter section being better. Two bores on the Myers and Levi farms in section 3 came in at only 5 barrels each, but the section as a whole ranks fair. There are but a few light wells in the east half of 4 now being pumped, the greater part of the section having been abandoned. There is no production in sections 5, 6 and 7, the southeast quarter of 5 having been abandoned, as has also all former production in section 8. In section 9 the Jones tract in the southeast quarter is fair territory, but the remainder is only light or abandoned. Section 10 is still producing, some of the wells having an average output, while more are light.

But one bore was sunk on section 11 during the year and it started at only three barrels, while section 12 is also light territory. The Overman and Nelson tracts, in the east half of 13, were abandoned during the year, while the remainder can only be classed as light. A deep pay bore on the Bartlett tract in the northeast of 13 was sunk 316 feet into Trenton. A light pay was reported at 285 feet in, but it was not sufficient to warrant the shooting of the well. Section 14 grades the same—the southwest quarter perhaps a little better. The greater part of the south half of 15 is yet fairly productive, but a portion of the west half of the section has been abandoned, although it was the best territory in 1903.

In section 16, the E. Van Vactor farm in the southeast quarter was once abandoned but is now fair producing territory. On the Horner tract in the northeast quarter of the section were sunk the best new bores of the year in the township; six of them, Nos. 14 to 19 inclusive, starting at 30 to 75 barrels each, while No. 13 was a dry hole.

The McClain and Steele leases on the west side of the river were in part abandoned. In section 17 the Hays and Overman farms are still fairly productive, while the rest has been, for the most part, abandoned, as has also all former productive territory in

sections 18 and 19 except the Davis tract in the southeast of 19, which has on it several light pumping wells.

Section 20 is yet all light productive territory except the south half of the southwest quarter, which has been abandoned. A dry hole was put down on the northwest quarter of 21, while the remainder is light. The northwest quarter of 22 is yet up to the average in production, but the remainder is lighter. The greater part of the north half of 23 has been abandoned, the remainder of the section being lighter. The best portion of 24 is in the northwest quarter. The Coulter tract, comprising the northeast quarter, has been abandoned, while the remainder is very light.

On October 1, 1906, Bell & Kilgore sold to the Corn Planters' Refining Company 1,300 acres of leases in sections 22 and 23, Centre, and 26 and 27, Mill townships, on which were 79 wells, making a total of 85 barrels per day, for $65,000.

Mill Township (Sections 25 to 36, 24 N., 8 E., and 1 to 12, 23 N., 8 E.).—This township, lying southeast of Marion, contains only 24 square miles. It is composed of parts of two congressional townships, and hence the sectional numbers are confusing. The area has proven very spotted in nature, and the map shows most of the available information regarding the grade of each section at present. A test bore sunk in July on the E. Thomas tract in the southwest quarter of section 25 resulted only in a small gas well. In 26 only the south half has been drilled and it has been abandoned. The Spencer tract in the center of the south half of section 29 has been abandoned, while new bores in the north half of 30 started at 40 or more barrels. Two dry holes were bored in section 35 and one in 36 during the year. A test on the Haines tract in the southeast quarter of section 11 started at 10 barrels. The northeast quarter of the section has on it three light producers and one dry hole. Several new wells with small output were drilled on the J. Hubert tract in the southeast of 12.

But 14 bores were sunk in Mill township during the year, while 19 old wells were abandoned. Of the new bores, three were dry and the 11 producers had a total initial output of only 77 barrels. The record therefore, is not a promising one for the future.

Fairmount Township (Sections 13 to 36, 23 N., 8 E., and 1 to 6 22 N., 8 E.).—This township first began to show oil in 1902. Most of its area had been for years under lease to glass companies and to corporations under contract to furnish gas to manufacturers. As the gas supply gradually failed a number of the old wells were drilled deeper and when shot and cleaned began to produce oil in

paying quantities. The year 1903 showed a great development in the southwest corner of the township, where three or four sections had an output above the average. Several sections along the north border have also yielded a number of light producers.

The wells sunk in the last two years have been much lighter and the output has dwindled to a small percentage of what it was in 1903 and 1904. During 1906 but ten new bores were sunk in the township. Of these six were dry while the number of abandoned wells was 48. The initial output of the four producing wells was but 23 barrels. The map shows the location of the abandoned territory, once productive, and also the grade of that now producing.

Dry holes were put down in the northeast quarter of sections 13 and 14 during the year. Some old gas wells were drilled deeper in the northeast of 14, but the results were not encouraging. A test on the La Rue farm in the southeast of 17 was also barren.

On the M. Wright tract of 136 acres in the southeast quarter of section 25, five wells two and a half years old were making a total of 7 barrels a day on November 1st. A record of No. 1 shows:

	Feet.
Drive pipe	190
Casing	370
Top of Trenton	950
First pay	975
Second pay	1030
Total depth	1050
Initial output, barrels	50

A bore, the site of which was located by a hazel rod diviner, was sunk on the Alfred tract north of Fairmount, to a depth of 1,300 feet, but found only salt water. All of the leases operated in sections 19, 30 and 31 by the Pittsburgh Plate Glass Company were closed down in February, as the production was very light and a heavy body of salt water retarded pumping. The leases in sections 4 and 5, southeast of Fairmount, which produced so heavily in 1903 and 1904, have also been for the most part abandoned, there being only a few light to fair producers in the west half of sections 4 and 3.

The only production in section 2 is on the southeast quarter. On the Mason tract of 42 acres there were three wells making six barrels per day on November 1st. Two wells had been abandoned. An average record showed:

	Feet.
Drive pipe	170
Casing	380
Top of Trenton	960
First pay	990
Second pay	1025
Total depth	1040

Liberty Township (23 N., 7 E., and sections 1 to 6, 22 N., 7 E.)—This township lies just to the west of the known productive territory of the main Indiana field. Only a few sections along its eastern side have produced oil in commercial quantities, and the most of the leases on them have been abandoned. At present there are only a few light wells pumping west of the town of Fairmount, in sections 23 and 25.

Franklin Township (24 N., 7 E.)—This township lies just west of Marion and only a small portion of it has been found to be productive. This was mainly in what is known as the West and South Marion Town Lot area, in sections 1, 11, 12 and 13, Franklin, and sections 17 and 18 Centre townships, where 209 producing wells were sunk in 1902 and 1903. These soon went the way of other town lot developments, the majority of them being abandoned before they paid out. All of section 11 was overcome by salt water and the last of the wells abandoned in October. The only production in the township is in the south half of 12, where 21 wells are yet pumping on the Coggeshall and other tracts, their average production being about one and a half barrels each per day.

Jefferson Township (23 N., 9 E., and sections 1 to 6, 22 N., 9 E.)—Up to 1903 this township was one of the big gas producing areas of the State. During that year a number of wells in different parts of the area began to show oil with the gas, and many of the old gas wells were drilled deeper and a number of new bores sunk for oil. Since then many of the undrilled sections have been tested for oil, but the results have, in the main, been disappointing, as only light to fair territory has been opened up. The status of the new wells may be gauged by the result of operations in the year 1906, when only 16 new bores were sunk. Of these three were dry while the 13 producers had a total of only 58 barrels initial output. During the year 40 producing wells were abandoned. The map shows the present grade of the territory which has been tested in the township.

In the north half of section 2, east of Upland, there are a number of pumping wells that average three and a half to four barrels

each; yet this small output grades them at present as fair producers. A test on the M. J. Brown lease in the south half of 11 came in dry. On the Jones farm in the southeast quarter of 19, where a tract of new territory was opened in 1905, but one bore was sunk, which started at only two barrels. Its record showed:

	Feet.
Drive pipe	187
Casing	375
Top of Trenton	933
Total depth	1035

Some better wells were drilled in the north half of 20, one on the Waite lease starting at 25 barrels. Of three bores sunk on the northeast of 27, one started at five barrels while the other two yielded water and nothing. Sections 29, 30 and 31 have only eight producing wells scattered throughout their areas. All are light in output, the best, Nos. 1 and 2 on the John Little farm, in the northwest of 31, starting at 15 and 20 barrels respectively.

MADISON COUNTY

lies south of Grant and west of Delaware and Henry counties. It comprises an area of 460 square miles, the surface of which is level or gently rolling. The drainage is to the southwest by way of White River, which crosses the county from east to west near its center, and has numerous tributaries permeating all portions of its area.

The railway facilities of the county are ample, the Michigan Division of the Big Four passing through it from north to south while the Cleveland Division connects Anderson, the county seat, with Muncie and Indianapolis. The P. C. C. & St. L. crosses the county diagonally from northwest to southeast. The Chicago and Southeastern (old Midland) crosses the county from east to west near its center and the L. E. & W. runs across its northern third. Besides these, the lines of the Union Traction Company run in various directions from Anderson and Elwood.

The elevations in feet above sea level of the principal railway stations in the county are as follows: Alexandria, 855; Anderson, 854-894; Chesterfield, 907; Elwood, 862; Florida, 881; Frankton, 834; Gilman, 901; Orestes, 871; Pendleton, 847; Summittville, 879.

Only the northern third of Madison County has produced pe-

troleum in paying quantities; and that only in limited areas in Boone, Van Buren and Monroe townships.

Boone Township (Sections 7 to 36, 22 N., 7 E.)—A number of bores have been put down in section 9 of this township, which have produced oil in commercial quantities. The only one sunk during the year was on the W. H. Davis farm in the northeast quarter of the section. It had an initial production of only 10 barrels. This region has yielded a large amount of gas in the past, and may in the future be more productive of oil. Where sunk any distance below the top of the pay streak there is much trouble with salt water.

Van Buren Township (Sections 7, 11, 14, 23, 26 and 35, 22 N. 8 E.).—This township has, up to the present, produced oil only in the northern tier of sections 7-11, next to the Grant County line, and in 21, just east of Summittville. In the northeast quarter of section 8, several bores, yielding only gas, were sunk on the Sluder lease in a vain endeavor to extend the Fairmount township, Grant County, pool in that direction. The C. S. Wood farm, in the southeast corner of 10, developed one or two light wells which have been abandoned, while three bores sunk on the C. M. Leach lease in the northwest quarter found gas alone.

Quite a pool was opened up in 1903 and 1904 in section 11, but the wells were for the most part light, and some of those in the northeast and southwest quarters have been abandoned, as has also the small productive territory east of Summittville. Not a bore was sunk for oil in the township during the year. Many of the old gas wells might yield oil if drilled deeper and cleaned, as they were originally sunk only a short distance into Trenton.

Monroe Township (Portions of 21 N., 7 E. and 21 N., 8 E.)—This is the township in which Alexandria is located, and in the immediate vicinity of that place a number of wells have been producing since 1899. The high gas pressure for a long time interfered greatly with their operation and the drilling of a number of dry holes in 1904 and 1905 has not added prestige to the region. As a consequence nearly all of the wells first in operation have been abandoned. But one bore was sunk in the township during the year. That was on the Frazier lease in the southeast quarter of section 28 and came in dry.

The only leases now producing in the township are the Bowers, in the northeast quarter of section 32, which may be classed as fair; the Jarrett in the southwest of 15, which is light, and the Painter lease in the southwest quarter of section 8, where a few light wells are still pumping.

HUNTINGTON COUNTY.

Huntington County comprises an area of 385 square miles, lying west of the counties of Allen and Wells and north of Wells and Grant. The general surface is similar to that of the counties already noted—a level plain, unmarked by any prominent hills or elevated points, the average elevation being about 780 feet above the level of the sea. The southern third of the county is drained by the Salamonie River, the central and northern thirds by the Wabash River and its tributaries.

The soil of the county is mostly of glacial origin, varying much in constituents and quality. In most places it is underlain by a stiff, tenacious clay which retains the surface water and necessitates artificial drainage. Where properly drained it yields large crops of the cereals and grasses. The alluvial soils of the extensive areas of bottom lands along the Wabash and Salamonie rivers are above the average in fertility, and their crops aid largely in giving Huntington the rank which it holds among the better agricultural counties of northern Indiana.

As in the other counties comprising the oil area of Indiana, the only outcrops of rock are those of the Niagara formation. In the vicinity of Huntington, the county seat, large quantities of lime are burned from this rock, and the quality of the product has given it a reputation second to none in the State.

Two railways, the Chicago & Erie and the Wabash, cross the county, the former from the northwest to the southeast, and the latter from northeast to southwest, while the T., St. L. & W. (Clover Leaf) cuts across the southeastern corner. The Fort Wayne and Wabash Valley Traction line parallels the Wabash Railway across the county.

The elevation in feet above tide of some of the principal railway stations in the county is as follows: Buckeye, 858; Huntington, 741; Markle, 814; Warren, 831.

The area of Huntington County producing oil in commercial quantities is practically limited to the southern halves of Salamonie, Jefferson and Wayne townships, along the southern border of the county. A bore sunk within known productive limits in this area is as sure a venture as one can make anywhere in the United States in the oil business. This is proven by the following table of statistics for the last four years:

	Total Bores.	Dry Holes.	Percentage of Dry Holes.	Average Initial Output, Bbls.
1903	312	10	3.2	19.4
1904	332	8	2.4	18.2
1905	161	2	1.2	19.3
1906	123	2	1.6	13.6

Not only is the percentage of dry holes less than in any other county in the State, but the wells hold up as well or better than elsewhere.

Wayne Township (E. 2-3 of 26 N., 8 E.).—This civil township comprises only 24 square miles in the southwest corner of the county. The oil production has been limited principally to the two eastern tiers of sections which lie east of the Huntington-Marion pike. Being on the western border of the main field and distant from railway facilities the operations partake somewhat of the wildcat variety. On that account, more new work was done in the township in 1906 than in either of the other two to the east.

Sections 1 to 4 and 9 and 10 are non-productive, the one or two light wells formerly drilled in the southeast of 1 having been abandoned. The east half of 11 and all of 12 are producing, but the wells are in general light.

The Pinkerton lease of 132 acres in the southeast of 12 has on it twelve wells which were producing an average of four barrels each in October. Two dry holes were sunk on the Billiter tract during the year. The east half of 13 is fair territory, as is also all of 24, the east half of 23 and all of 25. No. 3 on the Searles lease in the southwest quarter of section 24 pumped 90 barrels the first 11 hours, but No. 6 was dry. Several good producers were also finished on the Detamore tract in the southeast of 25, No. 4 starting at 80 barrels.

About 3,000 acres of leases in the southeast part of Wayne township are operated by the Wagner Oil Company. This company has sunk 121 wells in Wayne and Jefferson townships and claims never to have drilled a dry hole. But two bores were drilled by them in 1906, both on the southeast quarter of 36. A record of No. 7 shows:

	Feet.
Drive pipe	223
Casing	521
Top of sand	1037
Total depth	1087
Initial production, barrels	15

The net production of the Wagner company from their 121 wells operated on their leases during the year 1906, by months, was as follows:

	Barrels.
January	4961
February	3837
March	5029
April	3755
May	4290
June	4562
July	4428
August	3445
September	3880
October	5745
November	4052
December	4166

To the above the royalty of one-eigth should be added.

On the property of the Wagner company there is plenty of gas for operating. But little water is encountered, two-inch tubing being used in all the wells. Two pay streaks are found, one at about 25 feet, the other at 52 feet in the Trenton. Each pay runs five to 20 feet in thickness. A bore on the Bond lease in the west half of 36 was drilled 349 feet into Trenton in search of a deep pay, but without results. Ten wells drilled on the lease in 1904 and 1905 started at 70 to 120 barrels each.

Jefferson Township (26 N., 9 E.).—This is the best productive township in Huntington County. The wells mostly come in as fair to good producers, and hold up for a long time. Sections 6, 7, 8, 17 and 18, marked as undrilled on the former map, have since been pretty thoroughly tested. This territory was formerly mostly owned by the Huntington Light & Fuel Company, and utilized for gas. It was sold to the Wagner Oil Company and opened up for oil in the spring of 1905. This company drilled 6 test wells and, on October 4, 1905, sold them and 1,300 acres of leases to the Beatty-Nickle Oil Company for $15,000 cash. The latter company drilled 26 additional wells, but most of them were light, and they only brought the daily production up from 15 to 100 barrels. The map shows the present standing of the tested territory in the township.

A dry hole was drilled on the Boyd tract in the northeast of 4, and others in the southeast and northwest of 5 and the northwest of 6. Several leases in 5, 6 and 8 have been recently abandoned without being tested and there is at present no production in any

one of the three sections. A dry hole was sunk on the Boyd farm in the northwest quarter of 17 and two others on the northeast quarter of the same section. Section 21 and the north halves of 25 and 26 have yielded a number of light to fair wells.

In section 28 a number of wells, when first drilled, were only sunk 25 to 30 feet into Trenton. They have recently been drilled 50 to 60 feet in and then cleaned, resulting in 30 to 50 per cent increase in their output. Section 29 is one of the best in the township, almost every location being drilled. Some of the wells are three to four years old, but hold up remarkably well.

The Troy Oil Company has drilled 121 wells in sections 28, 29, 30 and 32 and are pumping every one. In 32 there are 68 wells on the 640 acres, which were averaging one and a half barrels to the well on November 1st. In November, 1903, the same 68 wells were making four barrels each. A record of an average bore on the section shows:

	Feet.
Drive pipe	200
Casing	450
Top of Trenton	1004
Total depth	1059

Gas is usually found at 15 to 24 feet in the Trenton before the oil is struck. The former is just about sufficient in quantity to operate the field.

Not over ten bores in the entire southern tier of sections 31 to 36 have proven barren. Two put down on the west half of the southwest quarter of 34 yielded salt water only. No. 7, on the Roberts lease in the southeast quarter, finished in July, had the following record:

	Feet.
Drive pipe	236
Casing	451
Top of Trenton	992
Gas	1007
Oil	1025
Water	1045
Total depth	1046
Initial production, barrels	75

Salamonie Township (26 N., 10 E.).—Operations in this township have been confined to sections 12, 13, 19, 20 and 25 to 36, inclusive, though isolated bores in other sections have produced a showing of oil. On the southeast quarter of 12 two dry holes

and two wells which started at 15 and 35 barrels have been drilled, while the only bore on the northeast quarter was dry. The top of Trenton in the last mentioned bore was found at 1,027 feet, while an average record of the bores on the southeast quarter showed:

	Feet.
Drive pipe	58
Casing	385
Top of Trenton	1007
Total depth	1087

The only drilling in section 13 has been on the McElhaney lease, northeast quarter, where two or three light producers were brought in. There is no gas in this region, and the wells, as well as those across the line in sections 7 and 18, Liberty township, Wells County, are pumped with a crude oil engine.

In sections 19 and 20, just west and north of Warren, a number of fair wells were drilled in 1900, but at present all have been abandoned except a few on the Jones tract, which yield one or two barrels each. Several dry holes on 20 stopped farther drilling northeast of Warren.

The oil bearing stratum about Warren is said to be rather solid and flinty and is not shattered as much by shooting as is the more porous pay streak in other parts of the field. It yields but little gas, but bears some pyrites, especially in the upper pay.

Section 36, near Mt. Zion, was formerly known as salt water territory. The water has now gone down and 25 or more new wells, all good ones, have been drilled on the section. The top of Trenton is here found at just about 1,000 feet and the bores are sunk 100 feet into that formation. The average well 18 months old makes about 2 barrels daily.

BLACKFORD COUNTY

comprises but 167 square miles, embraced in four civil townships. It lies west of Jay, south of Wells, east of Grant and north of Delaware counties. The surface is for the most part level or slightly rolling, the only hills being due to the eroding action of water. The soil, like that of the surrounding counties, is fertile, being of glacial origin and containing, therefore, all the constituents needed by the cereals and grasses. The principal products are the standard cereals, wool and live stock.

The Salamonie River flows diagonally across the northeastern corner and with its tributaries drains the northern half of the

county; while Lick Creek, a tributary of the Mississinewa, drains the southern half.

The Fort Wayne, Cincinnati and Louisville Railway crosses the county from north to south, and the Pittsburgh, Cincinnati & St. Louis from northwest to southeast, the two crossing at Hartford City, the county seat. The former is paralleled by the Muncie, Hartford and Fort Wayne traction line.

The elevations in feet above tide of the principal railway stations in the county are as follows: Hartford City, 896; Mill Grove, 931; Montpelier, 867; Renner, 907.

About one half of the county is at present producing oil, Washington township, in the northwest quarter, ranking among the best productive territory in the State. Harrison township contains much spotted territory. Montpelier, near its northern boundary, being the closest railroad town to the rich fields of the southern part of Wells County, has since the beginning of operations been one of the principal oil centers of the Indiana field. From it most of the drillers and operators of Wells and Blackford counties draw their supplies, and several Eastern companies which manufacture such supplies have branch houses located in the town.

Washington Township (24 N., 10 E.).—This township has a record for bringing in good producers in unexpected localities. Several of them were finished in 1906, and the township produced more oil than all the rest of Blackford County. The production has, however, fallen off gradually during the past three years, so that most of the sections marked good on the former map are now only fair or light.

A dry hole was sunk in November on the Williams farm near the center of 1, and most of the wells on the Leonard tract, northwest of 2 have been abandoned. Sections 1 to 6 are now all light, the old wells averaging one to one and a half barrels a day, while the new ones start only at 3 to 15 barrels.

The best wells drilled in Blackford County during the year were on the south half of section 7. On the Rix farm in the southwest quarter No. 1 started at 100 barrels while Nos. 2 and 3 made only 5 and 3 barrels respectively. No. 7 on the A. Nelson farm in the southeast quarter started at 100 barrels, and No. 4 on the L. Johnson farm, 500 feet south, at 140. The latter well, finished in May, is said to have yielded 80 barrels a day for three months, but by November 1st was down to five barrels.

All new bores in sections 8 to 10 were light. The southeast

quarter of 11 and the north half of 12 have been abandoned, while the south half of the latter section is very light. The area embraced in sections 13 to 18 is now all light, though part of it was formerly among the best in the township. The Bird lease in the southwest of 19 has been abandoned, as has also the Zimmerman tract, east half of the southwest quarter of 22. A bore on the J. Groff farm in the northeast quarter of 22 was sunk 600 feet into Trenton but was barren except in the shallow pay.

Section 31 in the southwest corner of the township developed a number of light to fair wells during the year. The Miles lease in the northeast quarter was the best, one or two of the wells starting at 100 barrels. A large supply of gas was produced with the oil. This lease had been previously cancelled by a company which had not deemed it worthy of testing. The Miles lease in the west half of the northwest quarter of section 32 also yielded two fair wells, while a test on the Fortner lease, just east, was barren. The south half of the section has as yet produced gas only, all the bores being sunk only a short distance into the pay. The southwest quarter of 33 and the southeast of 34 are as yet untested, while the remainder of the sections are light or abandoned. Section 36 has yielded oil only in the northeast quarter, but all the wells are now abandoned.

Licking Township (23 N., 10 E., and Sections 1-6, 22 N., 10 E.)—This township has proven a great disappointment to oil operators. It was thought, after the Hartford City pool was opened up in 1900, that a wide extension of good productive territory would be ultimately developed south and southwest of that city but the drill has, so far, failed to locate it. Most of the wildcat bores sunk in the township have come in dry, as water wells or as small producers. The pool in the northwest part of the Hartford City limits had the history of all other town-lot pools. While some good wells were opened, their production rapidly dwindled and, as but two or three could be hitched to one power, all but two or three of them were finally abandoned. While 70 per cent. of the wells in the pool probably paid out, not over 5 per cent. made a profit.

At present the production is limited to the northern two tiers of sections, the only new territory added since the former map being in sections 6, 7 and 8, where a number of light wells were brought in, most of which have been abandoned. The leases on a large acreage of territory in the southern part of the township, taken up for gas and oil, have recently been returned to the farm-

ers. These were mostly in sections 12, 13, 14, 19, 25, 27, 28, 33 and 35. The new map shows the present grade of the producing sections.

In 1906 a test on the Steele farm in the north half of section 5 started at 15 barrels. New work on the Johnson tract in the north half of 6, which in 1905 had yielded a number of fair wells, was not encouraging, as five bores resulted in two dry holes and only 13 barrels initial output from the three producers. The southeast quarter of 6, the east half of 7 and the northwest quarter of 8 were abandoned during the year, as was also all the producing territory in 9.

The northwest quarter of the northwest quarter of 10 has on it two producers, one a crevice well five years old, that is said to be still yielding 10 barrels a day. All other former producing wells in the township have been abandoned except a few in the southeast quarter of 22 and the north half of 27.

Four producers with an initial output of 28 barrels and four dry holes were completed in the township during 1906, while 20 wells were abandoned.

Jackson Township (23 N., 11 E.)—Although this was formerly counted one of the best gas producing townships in the State, only a few sections in the northwest corner have yielded oil, and the wells on them have been abandoned. Where the gas has been exhausted salt water has taken its place. Therefore the chances of successful drilling for oil over the greater part of its area seem at present very slight. Many of the leases held for gas and oil were cancelled during the year.

During the deep pay excitement in the Muncie field in 1904 several bores were sunk in search of deep pay oil in this township, but without results, gas only being found and that in the upper pay. The location and depth of three of the bores were as follows:

J. A. Painter tract, S. E. ¼ Sec. 1, 300 feet in Trenton.

Thomas Day tract, S. ½ N. W. ¼ Sec. 13, 450 feet in Trenton.

H. Flatter tract, E. ½ S. W. ¼ Sec. 21, 440 feet in Trenton.

Harrison Township (24 N., 11 E. and Sections 6, 7, 18, 19, 30 and 31, 24 N., 12 E.).—This township comprises 42 square miles, 27 of which have produced oil in commercial quantities. One of the oldest wells in the State, drilled in 1890, is located in the southern outskirts of the town of Montpelier. It started with a good flow of gas and about 25 barrels of oil and is said to be still pumping. Many of the first producing leases in the township have been

abandoned in the last two years and the output of all has greatly decreased. The map shows the present grade of those still yielding.

Section 6 in the northeast corner is one of the best in the township. On the Shinn farm of 80 acres in the northeast quarter, 10 wells were sunk, the last one of which yielded eight tanks the first month and seven tanks the second. It was the best well on the tract, and proves that one cannot foretell what a lease will yield until it is thoroughly drilled. The well is now three years old and yielding only one and a half barrels per day.

On the Dawley lease in the northeast corner of the section a bore to deep pay was drilled which came in barren and had the following record:

	Feet.
Drive pipe	106
Casing	330
Top of Trenton	1061
Total depth	1436

The Lacy tract, southeast quarter of 11, after being once abandoned by the Ohio Oil Company, was taken up by the Federal Oil Company and nine wells drilled on it, all of which were light producers. It was abandoned a second time in June, 1906, when the nine were making a total of only two and a half barrels a day.

Leases on the Stoller tract of 160 acres in section 35 and the Walker farm of 80 acres in 29 have been recently cancelled. A bore on the Deerduff lease, east half of the northeast quarter of 30, was sunk 352 feet into the Trenton, but without results. Another deep pay, also dry, was sunk on the Taylor farm, southwest of 32, to a depth of 435 feet into Trenton.

But five producing wells, with an initial output of only 27 barrels, were drilled in the township during 1906, while 42 were abandoned.

WELLS COUNTY

comprises an area of 367 square miles lying south of Allen, west of Adams, north of Jay and Blackford, and east of Huntington and Grant counties. The surface of the county is level or gently rolling. The average altitude above sea level is about 850 feet. The Wabash River flows diagonally across the county, entering it on the eastern side, a little below the center, and flowing in a northwesterly direction. The Salamonie flows across the southwestern corner in the same direction, and these streams, with their

numerous smaller tributaries, furnish an abundance of running water and, in most townships, an ample system of drainage.

The soils of Wells County are above the average in fertility. Made up of a mixture of ingredients derived mainly from the decaying rocks of the far north, ground fine and thoroughly mixed as they were by the mighty glaciers which brought them to their present resting places, they contain all the necessary constituents for the growth of the cereal crops, and therefore do not require an annual outlay for artificial fertilizers. Corn and wheat yield abundantly in the southern and western portions of the county, and the majority of the farmers were in good circumstances long before the drill revealed that another resource which had been stored since the old Silurian days lay far beneath the surface of the soil they tilled.

Two railways, The Toledo, St. Louis & Western (Clover Leaf) and the Ft. Wayne, Cincinnati & Louisville, pass entirely through the county. The Chicago & Erie touches its northern border, while the C. B. & C. runs southeast from Bluffton to Portland, Jay County. The Muncie, Hartford & Ft. Wayne electric line parallels the Ft. W., C. & L. Railway and furnishes easy outlet to the northeast and southwest; while the Marion, Bluffton & Eastern, just completed, furnishes another mode of transportation to the westward.

The elevations of the principal railway stations of the county above sea level are as follows: Bluffton, 835; Craigsville, 850; Keystone, 862; Kingsland, 856; Liberty Center, 848; Murray, 853; Poneto, 849; Tocsin, 837; Uniondale, 814.

Wells County contains the oldest oil producing area of the State, and for a number of years ranked first in production of petroleum; but since 1901 has been exceeded by Grant and Delaware counties. However, the townships of Nottingham and Jackson still rank as among the best productive territory in Indiana. As few dry holes are drilled in them as in any other similar area, and a number of new productive wells are each year added to those already existing. Chester township is more spotted, and a number of the more recent bores sunk within its area have proven very light or dry. Outside of the townships mentioned, but small areas in Liberty and Harrison townships have as yet proven productive, and it is not likely that much oil will be found in the county north of the present limits shown on the map, though the western part of Liberty township may yet develop several sections of light productive territory.

As in other areas of the main field, the old wells have fallen down

greatly in production, while numerous leases have been wholly abandoned. The map shows the present grade of the area now producing.

Jackson Township (25 N., 10 E.)—This township is now regarded as the best territory in Wells County. Nottingham has produced more oil, but recent bores sunk in Jackson have had a larger initial production and the old wells are holding up better than farther east in the county. The G. W. Huffman tract on the southeast quarter of section 1, just southwest of Mt. Zion, has had a checkered career. It was first leased by the Ohio Oil Company, which drilled 13 fair to good wells upon it. Some of them were overcome by salt water, others were pumped dry and the lease was finally abandoned. In 1906 it was re-leased by M. Long of Bluffton, who sunk three new bores between some of the old locations. These started at about 35 barrels each and No. 1, 40 days old, was making five barrels in November. The top of Trenton is found at 1,000 to 1,010 feet and the oil between 25 and 40 feet lower. Below this a heavy body of salt water is encountered. Several bores on the L. Huffman lease, just east, started at 5 to 15 barrels, while one was dry. The Alexander tract in the southwest of 5, after having four dry holes drilled upon it, was abandoned, then re-leased and another one yielding salt water only, was completed.

Some of the best territory in the township is found in the north half of 13, the west half of 14 and all of 15 and 16. The old producers in this area hold up well and the new ones start above the average. A test bore on the Tucker lease in section 20 came in dry. Seven or eight bores were put down during the year on the Jones tract, southeast quarter of 32, which started at five to 20 barrels, with the exception of No. 4, which was dry. One on the L. Cocheran farm, section 33, was also dry.

It will be seen by the map that every section in Jackson township is productive. Very little territory has as yet been abandoned. The new wells average much lighter than were those first drilled, but a very high per cent. of them yield oil, there having been only 4 dry holes drilled in the township during the year, while the number of producers finished was 73, with an average initial output of 7.2 barrels.

Chester Township (25 N., 11 E.)—More new work was done in Chester township in 1906 than in either Jackson or Nottingham. This was mostly on leases already in operation, which had not been as closely drilled as in the other townships. While the producers were mostly small, starting from five to 15 barrels, they hold up well and in time yield a fair profit to both operator and farmer.

Section 1 has so far yielded only a few light wells in the southwest quarter, while the northeast quarter of 2 is undrilled. In section 3 the C. Starr and J. Bowers tracts have been abandoned, as has also the Shadle farm in the southwest of 18.

A number of new wells on the north half of 20 and the south half of 21 came in as light producers. Some of the best wells of the year in the township were on the Irvin leases in the southeast of 23 and the southwest of 24, several of them starting at 50 to 90 barrels. Two dry holes were drilled on the Showalter tract just east of the Irvin in the southeast of 24. Sections 25, 26, 35 and 36, in the southeast corner of the township, have fallen off greatly in production and a number of the old wells have been abandoned. On the Spellacy lease in the south half of 26, 15 wells were making but one-half barrel net each per day in November, but as only one man was required to pump them the lease yet pays well to operate. A dry hole was sunk on the C. Abshire lease, northeast of 25. The sections in the southwestern part of the township are all light in output.

Nottingham Township (24 N., 12 E. and the west two tiers of sections in 25 N., 13 E.)—This is one of the oldest and best producing oil areas of the State, a number of the wells having been drilled in 1891. In late years, however, the decline in production has been rapid, as the new wells were mostly light. As a consequence many leases have been abandoned.

As shown by the map, there has been little or no production in the northeast quarter of the township. A large portion of section 5, in the northwest corner, has been recently abandoned, as has also a part of the southeast of 7 and the southwest of 8. A number of "second crop" wells, starting at 15 to 30 barrels, have been drilled in sections 17 and 18 on farms which had been abandoned and then re-leased. One of these on the Dickinson tract, in the northeast quarter of 18, had the following record:

	Feet.
Drive pipe	38
Casing	332
Top of Trenton	1005
Total depth	1050
Initial output, barrels	30

When 40 days old the production was seven barrels per day, and it is estimated that the well will yield two barrels at the end of six months. A bore on the Bryan farm, northwest quarter of 19, was sunk 370 feet in the Trenton in search of deep pay, but without results.

Nos. 1 and 2, on the Dulinskey farm, southwest of 22, started at eight and ten barrels respectively. The Dall tract in the same section has been abandoned, as has also the southeast of 26 and scattered wells in 27. In sections 30 to 34 many of the wells have been abandoned and those remaining are pumped long distances, isolated wells sometimes being one-half mile from the power. The north half of 35 has been abandoned, while a test on the Romans farm in the southwest quarter of 36 came in barren. In fact, the southern two tiers of sections, comprising 16 square miles, once the cream of the main Indiana Trenton rock field, have been reduced to strippers which yield not more than one-third of their former output.

Harrison Township (26 N., 12 E.)—Only the southern portion of this township has been tested and the results were mostly negative. Dry holes have been drilled on the center of the southwest quarter of section 19; in the northeast corner of the northeast quarter of 29; on the southwest quarter of the same section; on the southeast corner of the northeast quarter of 31; on the south line of the west half of the northwest quarter of 32, and on the northwest quarter of 36.

Light producing wells were completed in 1904 and 1905 on the J. E. Valentine tract in the southeast quarter of 32, and on the Harnish, in the southwest corner of 33, but have since been abandoned. Two light producers on the Barton farm in the southwest of 32 are still pumping. No bores were sunk in the township in 1906.

Liberty Township (26 N., 11 E.)—The only producing territory in this area of 36 square miles is on three or four sections in the southwestern corner. Bores have been put down on eight or ten other sections, most of which came in dry or very light producers.

In the northwestern part of the township, sections 7 and 18 have developed four or five light wells and several dry holes. The production is mostly on the Thompson lease, in the southwest quarter of 7, and is from a part of the pool opened up just to the west in section 12, Salamonie township, Huntington County. A dry hole has been sunk on the southeast corner of the same lease, and another on the Messburg farm on the same section. There is no gas to operate the power and crude oil is used for that purpose.

The light producers marked on the former map as yielding in the southwest of 18; the northeast and southwest of 17; the southeast of 19 and the southwest of 21 have all been abandoned. Dur-

ing 1906 dry holes were drilled on the southwest of 19, the northeast of 31 and the northwest of 34. In the latter the top of Trenton was struck at 1,016 feet. The salt water was cased off and the drilling continued to a depth of 1,593 feet, or 487 feet into Trenton. What the drillers call "buckwheat sand" was found all the way below 1,116 feet.

ADAMS COUNTY

lies adjacent to the Ohio State Line and south of Allen, east of Wells and north of Jay counties. It is 24 miles in length from north to south, and 14 miles in breadth, comprising, therefore, an area of 336 square miles. The surface is comparatively level, but is well drained by the St. Mary's and its tributaries in the northern half, and the Wabash and its tributaries in the south. Three railways pass through the county—the G. R. & I. from north to south; the T., St. L. & W. (Clover Leaf) and the Chicago & Erie from east to west; the three having a common junction point at Decatur, the county seat.

The elevations in feet above tide of the principal railway stations in the county are as follows: Berne, 849; Ceylon, 849; Curryville, 842; Decatur, 800; Geneva, 840; Monmouth, 788; Monroe, 822; Peterson, 817; Pleasant Mills, 799; Preble, 813.

Only the southern third of Adams County has as yet produced petroleum in commercial quantities. The townships of Hartford and Wabash, in the southwestern corner of the county, possess the oldest wells; while Jefferson and Blue Creek, on the east, have, in recent years, yielded quite a number of producers, but they do not hold up as well as those farther west.

As in other parts of the Indiana field, many of the older wells are being abandoned, and all of them are much lighter in output than a year or two ago. The map shows the present status of the producing sections.

Blue Creek Township (Sections 3 to 10, 15 to 22 and 27 to 34, 26 N., 15 E.)—Most of the new development in recent years has been in this township and in Jefferson to the south. Only about half of the area of 24 miles is or has been productive, and that is in the southern portion. All former production in sections 9, 10, 16 and 17 has been abandoned, but a few light wells are yet pumping on the south half of 15. The Grim tract in section 27 has been recently abandoned, but the remainder of the section, as well as 22, to the north, is lightly productive.

In 21 and 28 dry holes represent the only bores. The Pruden lease in the southwest quarter of 29 has seven light wells and one dry hole to its credit, while the only production in 30 is from a single well in the southwest quarter.

Section 31, once famous for its good wells, which were the first drilled in the township, is now all light territory, with many of the old wells abandoned. The Federal Oil Company, which a few years ago bought the holdings of the Superior Oil Company, the pioneers of Blue Creek Township, operates the most of the wells in section 31. The 214 wells of the Federal Oil Company in Adams County, yielded an average of only 175 barrels a day during the months of September and October, which was about eight-tenths of a barrel per well per day. However, even at this rate they pay well for operating.

The west half of 32 is still producing, but the east half has been abandoned. A dry hole on the southeast was put down 232 feet into the Trenton. In 33 the only bores finished have been barren, while 34 has some light producers on the southeast quarter.

But one bore was sunk in Blue Creek township during the year 1906, while 17 old producers were abandoned. The new bore was drilled on the Studebaker lease in the southeast of 31 and started at 20 barrels.

Jefferson Township (Sections 3 to 10, 15 to 22, and 27 to 34, 25 N., 15 E.)—This township comprises but 24 square miles of congressional township 25 N., 15 E., the two eastern tiers of sections of the congressional township being a part of Mercer County, Ohio. The first producing wells in the township were opened up in sections 19, 20, 29, 31 and 32, in 1900. Since then a number of fair wells have been drilled in the south half of the township, but except in sections 5, 6 and 16, most of the tests in the north half have proven dry or very light.

Section 3 in the northeast quarter is one of those which so far have proven barren, while the only production at present in 4 is in the south half. Sections 7, 8 and 9 are as yet also barren, a dry hole on the Macy tract in the southwest quarter of 7 and two or three of the same kind in each of sections 8 and 9 representing the bores hitherto put down. The southeast quarter of 16 has eight fair wells to its credit, but the remainder, as well as most of the territory in 15, 17 and 18, is abandoned or dry. Section 22 has proven one of the best in the township, several bores on the Yaney and Fetters tracts starting during the year at 40 to 60

barrels, while the Huffman lease in the northeast quarter is up to or above the average.

Tests drilled during the year on the Finety and Rehart leases in the north halves of 27 and 28 started at 8 and 40 barrels respectively. The best well of the year in the township was No. 7 on the H. Fogle farm in the northwest of 32, which yielded 110 barrels the first 24 hours, while three others on the same lease started at 15 to 20 barrels. During 1906, 29 bores were drilled in the township, while 32 old wells were abandoned. Of the new wells but one, Huey lease, section 31, came in dry. The 28 producers had an average initial output of 9 barrels each.

Wabash Township (25 N., 14 E.)—Excepting three or four of the southwestern sections, the greater part of this township has proven very spotted, unsatisfactory territory. The lob, or "deep drive," passes from northeast to southwest diagonally across the township and has, up to the present, prevented drilling in a number of sections which might produce much oil. Many of the old wells were pulled during the year and the materials shipped to other points.

All tests made to date in sections 1 to 6 have yielded salt water only, while 7 to 12 have proven but little better. A test on the A. L. French tract in the northwest of 7 came in dry, while all old producers in 8 and 9 were abandoned during the year. One fair well was drilled several years ago on the Farlow tract in the southeast of 10, but as there was no pipe line and no gas for fuel, it was abandoned, as was also all the former producing light wells in sections 13, 14, 16 and 17. The Koeser farm in the southeast of 19 yielded two 75-barrel producers during the year and two others of about one half the size. The south half of 20 has some light wells, but all former producing territory in 21 to 26 has been abandoned.

Sections 28, 30 and 31, which were marked good on the old map, have dwindled in output until the territory is mostly very light; the west half of 30 being the best. In the south half of 31 the top of Trenton is found at 980 and the oil at about 1,005 feet. Many of the wells which started at 50 to 75 barrels two or three years ago are down to one and a half barrels or less at present.

A test bore on the Kramer tract in the southwest of 34 started at 12 barrels, but the former production in 35 has been abandoned, while that in the north half of 36 soon will be.

During the year 1906 nine producing wells and one dry hole were drilled in the township, while 47 old producing wells were abandoned.

Hartford Township (Sections 1 to 4, 9 to 16, 21 to 28 and 33 to 36, 25 N., 13 E.)—The southern half of this township has been the most productive territory in Adams County. It was the first drilled, yielded the biggest wells, and has held up better than any other. Here, as elsewhere, however, the output has fallen off greatly within the past few years. But few if any leases have been wholly abandoned, but the weaker wells on many of them have been thinned out.

The productive territory farthest north is in section 12, where two or three light wells were finished on the Yoder tract in the southeast corner, while a test on the Martin lease in the northwest was too light to pump.

On the Zehr tract in the southeast of 24 are two big water wells thirteen years old. These are but 75 feet apart, yet they made hundreds of barrels of water and enough oil each day to fill eight tanks a month for seven years and are still producing three tanks of oil a month. The Porter lease of 240 acres in the southeast corner of section 25 is an average one for the south half of the township. It is fully drilled, having upon it 27 wells, two of which have been abandoned, while the last one drilled was completed in 1904. The production of the lease in November, 1906, was 40 barrels per day.

During the year the township yielded six producing wells and one dry hole, the former having an average initial output of only seven barrels, while, of the old producing wells 20 were abandoned.

All of the old productive territory in Monroe township north and east of Berne has been abandoned.

JAY COUNTY

comprises an area of 370 square miles, lying adjacent to the Ohio State Line, south of Adams and Wells, north of Randolph and east of Blackford and Delaware counties. The surface of the county is gently rolling or nearly level, and the soil of most portions proves very fertile where properly drained and tilled. The Salamonie River flows through the county from southeast to northwest and drains its western and southern halves. The Wabash River touches its northeastern corner and through its tributaries drains the townships of Wabash, Bear Creek and Jackson.

The G. R. & I. Railway, passing north and south through the center of the county, crosses the L. E. & W. main line, running east and west, at Portland, the county seat. The P. C. & St. L.

crosses the southwest corner of the county, passing through the thriving towns of Dunkirk and Redkey, and the C. B. & C. runs northwest from Portland to Bluffton. In addition to these the Muncie and Portland traction line passes from Muncie through Redkey to Portland, so that the facilities of transportation in all directions are excellent.

The elevations above sea level of the principal railway stations in the county are as follows: Blaine, 930; Briant, 869; Brice, 924; Como, 949; Dunkirk, 946; Portland, 909; Powers, 991; Redkey, 966.

During the past two years Jay County has been the seat of the most active operations in the main Indiana Trenton Rock Oil field. Practically the only new territory added to the area of that field in 1905 was in Bear Creek township, and in 1906, while but one or two new sections were opened up, they yielded more new production than any similar area in the State. The new territory does not start off so well as the famous Pennville, Harris and McCallister pools, which a dozen years ago were known and talked of wherever oil men congregated, but it is very much above the average of new development in recent years, and the wells hold up remarkably well.

Many of the older wells in Jackson and Penn townships have been abandoned, and in a number of cases the leases re-leased and re-drilled, the "second crop" wells yielding sufficient profit to more than justify the expense.

Bear Creek township especially was the seat of active operations in 1905 and 1906, most of the territory drilled with success being that which had been condemned by an occasional dry hole, ten to a dozen years before. The map shows the grade of the producing territory at present being operated, and only new developments of general interest are herewith noted.

Wabash Township (Sections 3 to 10, 15 to 22 and 27 to 34, 24 N., 15 E.)—Some new territory has been added to the productive area of this township shown on the former map, but a number of dry holes have rendered it a far more uncertain quantity than the township to the west.

Most of the south halves of sections 4 and 5 have been abandoned. On the Ralston tract in the southwest of 4, several bores were drilled in 1906, but all were light, starting at one to 12 barrels, and they have been abandoned. No new drilling has recently been done in sections 6, 7 and 8. The west half of 7 was once very productive, but all the wells have dwindled until they are very light.

Tests on the Stolz tract, north half of 9 and on the Bricker and Lesher leases in the west half of 17 came in dry or very light. A number of dry holes have from time to time been drilled in the south half of the township. One in the northeast quarter of 32 is said to have been located by "spirits," who assured the owner that he had a lake of oil beneath a certain portion of his farm, and that a bore there located would surely strike it. However, the "tip" of the spirits proved no more successful than that of the hazel rod in the hands of the oil wizard or other fakir. Two light wells are located in the south half of the section.

Bear Creek Township (24 N., 14 E.)—As above noted, some of the best territory drilled in 1905 and '06 was in this area of 36 square miles, sections 28 and 29 proving especially rich. The depth to top of Trenton ranges from 1,014 to 1,035 feet, due mainly to the variation in surface level, there being an actual difference of 12 to 15 feet in the exact level of the Trenton in different parts of the township. Sections 1 and 2 have so far proven mostly light or dry. A bore which came in wholly barren on the Boehn tract in the northeast of 2 was shot and started at more than 100 barrels.

A number of fair wells were drilled in new territory in the north half of section 3 during the year. On the Bryan lease in the northwest quarter Nos. 1, 2 and 3 started at 60, 20 and 40 barrels respectively, while a test on the Shoemaker lease in the northeast made 42 barrels. The southwest quarter has so far yielded only one dry hole, while a light well on the southeast quarter was abandoned.

Some good wells have been found on the southeast of 5, one on the Lineberry tract starting at 125 barrels. Section 7, once good, has decreased much in output. A crevice well on the Sanders tract in the northwest quarter has had quite a history. It started at 90 barrels and held up to 50 barrels for some months, then began to alternate with oil and water, pumping one or the other alone often for weeks at a time. It is now six years old and doing ten barrels of oil per day. A number of second crop wells between the old locations have been recently drilled on this and adjoining sections, most of them starting at 20 to 35 barrels each.

Sections 9, 10 and 16, now in part fairly productive, were at one time owned by the Cudahys, who, after drilling two or three light wells or dry holes, abandoned the territory.

In section 19 there appears to be a high streak of the Trenton, and the tests have yielded gas with only a showing of oil. The

leases have mostly been abandoned, but the section may be re-drilled with profit after the gas pressure subsides. Sections 20 to 27, inclusive, have as yet only light oil or gas wells. Several dry holes have also been drilled within their bounds. A bore on the Beal tract in the southwest of 26 yielded 3,000,000 cubic feet of gas which will be piped to Portland.

On the west half of Section 28, fifty or more wells were sunk during the year, it being the most active territory in the Indiana field. The Scotland Oil Company of Bluffton have been among the most successful operators. This company bought the untested Kuhn tract of 40 acres in the southwest of the northwest of 28, paying therefor $1,100. On it they sunk six bores, all of which came in as good producers. Up to November 1st the farmers' royalty of one-sixth had amounted to $2,400. The records of Nos. 1 and 6 on the Kuhn lease showed:

	No. 1.	No. 6.
	Feet.	*Feet.*
Drive pipe	78	104
Casing	245	238
Top of Trenton	1004	997
Total depth	1050	1048
Initial output, barrels	80	180

No. 1 was completed January 20 and No. 6 on March 17, 1906. The latter well was making 15 barrels on November 1st.

The Scotland Company have thirteen producing wells and one dry hole on the Kuhn and Flauding tracts, the latter being in the northeast quarter of section 29. Two powers are used, while one well is pumped from the beam. The net output of the 13 wells by months for the year 1906 was as follows:

	Barrels.
January	453
February	1126
March	3124
April	2561
May	2035
June	1696
July	1636
August	1898
September	1325
October	1347
November	1323
December	1304
Total	19.828

To the above the royalty of one-sixth should be added.

The Shimp tract just north of the Kuhn and operated by the Superior Oil Company, of Geneva, was also an excellent one, 14 producing wells having been completed on it during the year.

The wells on the east half of section 28 were lighter, the sand being more erratic. On the Roseborough and Easterday farms in the south half of the section there are 21 producing wells which were making 150 barrels net on November 1st. Nos. 1 and 2 Easterday, and No. 6 Roseborough started at 150 barrels each, both flowing oil for a day or two. But one pay streak is found in this portion of Bear Creek township, being struck anywhere from 15 to 40 feet below the top of Trenton.

In section 29 the best production is on the Flauding tract in the southeast quarter of the northeast quarter. On the Ray, in the northeast of the southeast quarter two bores resulted in a dry hole and light producer. The field record for the dry hole and of the No. 1 Flauding were as follows:

	Ray. Dry hole.	*Flauding No. 1.*
Drive pipe	138	65
Casing	235	235
Top of Trenton	1005	1000
Total depth	1087	1046

The west half of 29 and all of 30 have developed gas only. Sections 31 to 33 are in part lightly productive, while on 34 the only two tests developed big gas wells which sprayed large quantities of oil for a long time.

Jackson Township (24 N., 13 E.)—In the northern part of this area of 36 square miles is some of the oldest and formerly the most productive oil territory of Jay County. In recent years, however, a number of the farms have been abandoned, while the output of all the wells has fallen down to a small fraction of what it was when the territory was first drilled. In a number of instances the farms have been re-leased and a second crop of wells drilled, usually with fair results; though few if any of these new bores started above 40 barrels.

Sections 1 to 5, marked good on the former map, are now light, the average production being little if any over 1 barrel per day for each producing well left. During 1906 one dry hole and a very light producer were drilled on the H. Bair lease in the northeast quarter of section 3, while the south half of 6 and the northwest quarter of 7 were abandoned.

On the Buchtell tract in the southeast of 10 is a crevice well

ten years old which, when first drilled, made 101 250-barrel tanks in 100 days. In it the best pay was found 52 feet in Trenton, while in other wells around it the oil was found only 15 to 18 feet below the top. In the spring of 1906 this well was down to three barrels a day and was cleaned and shot, but without increasing the output to any extent. Another well 150 feet distant on the adjoining lease, was soon after cleaned and shot, also without results, except to cause the Buchtell well to break loose and produce 50 barrels a day for several months.

The south half of the township, sections 18 to 36, inclusive, is very spotted territory. Many of the leases formerly drilled have been abandoned, while a number of bores which came in dry have been sunk in the past two years. The Richison tract in the northwest quarter of section 30 is probably the best lease in this part of the township, No. 17 on it coming in during the year at 45 barrels.

Penn Township (24 N., 13 E., with the exception of the west tier of sections.)—Some of the famous pools in the early history of oil operations in Jay County were located in this township. On account of the lob, or "deep drive," which runs through the north central portion and renders drilling very tedious and often expensive, a number of sections are as yet non-productive. An old preglacial river channel doubtless exists beneath the lob. This was cut 200 feet or more into the Niagara limestone, then filled up and covered with drift by the glacial invasion, so that it is not uncommon to use 400 or more feet of drive pipe in the bores sunk in it before striking limestone. As a result, the region of the lob has been avoided. The wells sunk near it have mostly come in as fair to good producers, and should the price of oil ever rise to a figure which would justify the expense, there is little doubt but that the lob district would become very productive territory. In the last year, the only new work in the township has been in territory formerly condemned or abandoned, then re-leased and redrilled to 65-foot pay, the older wells having yielded most of their production from the upper or shallow pay. Sections 25 and 26 and the east halves of 27 and 35, comprise the bulk of this newly drilled territory, and a number of others now in part or wholly abandoned would doubtless well repay a second and deeper drilling.

Section 2 and the south halves of 3 and 4 have been abandoned, while all the remainder of the north tier is now light. No. 8 bore on the Pugh tract in the northeast quarter of section 8 started

at 105 barrels in November, being the best finished in the township for some time.

Noble Township (23 N., 15 E.)—But little oil has as yet been produced in this area, though a number of bores have been sunk in search of it. The northwest quarter of section 3, the northeast of 4 and the northeast of 17 have each from one to three light producers to their credit, while others which pumped a while have been abandoned in the northwest of 5 and the southwest of 27. No pipe lines have as yet been laid to any of the producers, so that their real capacity has not been determined.

Wayne Township (23 N., 14 E.)—But few wells are at present producing oil in commercial quantities in this area. About one-third of the 36 sections have been tested, but the bores have, for the most part, produced gas or salt water only. Such as did produce oil had such a small output that pipe lines were not laid to them and they have been abandoned.

One or two bores which are said to have started at ten to 40 barrels each were drilled in the northeast quarter of section 4, the southeast and southwest of 5 and the southeast of 6, but no one of them is pumping at present.

Three old gas wells in the north half of section 22 are said to have been recently drowned out with oil. A bore in the southwest quarter of the section was drilled 26 feet into Trenton and shot, when the oil rose 300 feet and the well pumped 40 barrels. It was concluded that the sand had not been penetrated far enough, so the tubing was pulled and it was drilled 15 feet deeper and a second shot made, which reduced the output to ten barrels, so that it was soon abandoned.

Other small producers have been abandoned in the southeast of 10, the northeast of 18, the southeast of 21 and the northwest of 26.

Greene Township (23 N., 13 E.)—About one-third of this township has also been tested, but without paying results, there being only a few light producing wells within its area.

There is one light well in the southeast quarter of section 1 and two or three gas wells, which show a quantity of oil in the 65-foot pay, in the southeast of 17; also a light producer in the northeast of the same section.

On the A. Ziegler tract in the north half of the southwest quarter of 19 there is a well which has filled two 250-barrel tanks from the 65-foot pay and would make 15 barrels a day if pumped, but there are no pipe line facilities. A second attempt on the same

lease resulted in a dry hole. Some former producing wells near the center of 24 have been abandoned.

Knox Township (Four eastern tiers of sections of 23 N., 12 E.)—Only three sections of this area of 24 square miles have been tested for oil. Three light wells have been brought in on section 1, two in the northeast quarter and one in the southwest quarter. They are not now being operated but have not been abandoned, as have the other producers in the southwest of 11 and the northwest of 4.

Richland Township (22 N., 12 E.)—This civil township, in which the thriving towns of Dunkirk and Redkey are located, comprises but 26 square miles. It lies east of Niles township, Delaware County, and in it have been sunk a number of deep pay bores, some of which came in as fair producers but, as in the deep pay territory east of Muncie, most of them have recently been abandoned. The million-dollar gas pumping station at Redkey has also been abandoned on account of the failure of that volatile fuel.

There are two or three light producers on the south half of 10, but a recent test on the McKinney in the northeast of 12 came in dry. Former producing wells on the northeast of 13 and the southwest of 16 have been abandoned. A bore 2,600 feet deep, was drilled through the Trenton into Potsdam sandstone on the Phillips tract, southwest of 22. A little oil was found 410 feet below the top of Trenton, but not enough to pay for shooting.

A dozen or more good deep pay wells were completed just east of Redkey on the north half of section 24, but the companies operating them have recently broken up financially and the majority of the wells have been abandoned. Some of them started at 100 to 180 barrels per day and when put to pumping regularly made 50 to 60 barrels, but there was no gas to operate and salt water soon got the better of most of them. The south half of the southwest quarter of the section is yet fairly productive.

The best well drilled in Jay County during the year was No. 3 on the Landauer tract in the east half of the northwest quarter of 25, which yielded 300 barrels the first 24 hours, but No. 4, only a short distance away, made but five barrels; while of three on the Corder lease just west, one was barren and the other two light. Four dry holes have been drilled on the southwest quarter and one on the southeast quarter of the same section, while the northeast quarter has been abandoned. The top of Trenton in this vicinity is found at about 1,040 feet.

Pike Township (22 N., 14 E.)—Bores for oil have been sunk

only on four or five sections of this township, but none of them have developed the fluid in good paying quantity. A test sunk in 1906 on the Cook tract in the northwest quarter of 19 started at only two barrels. In the south halves of sections 8 and 9 are some seven or eight wells which average about one barrel each per day, the product being pumped into tanks. A bore drilled for gas on the northeast quarter of 34 filled up with oil and ran over the casing but as the farm is distant from railways and pipe lines no farther tests were made.

Madison Township (22 N., 15 E.)—Six sections in this area of 30 square miles have been tested, but most of them yielded gas only. A light well was drilled in on the southeast quarter of 15 and another in the northwest of 23, but as there were no pipe lines they were not pumped. In them the top of Trenton was struck at 1,080 feet, but in some big gas wells in the south half of 33 it was 40 feet higher.

RANDOLPH COUNTY

comprises an area of 450 square miles lying next to the Ohio State line, and south of Jay, north of Wayne and east of Delaware and Henry counties, Indiana. The surface of the county is generally level or rolling, but the area which it embraces is one of the most elevated in the State, its southern part forming the principal watershed of eastern Indiana. The numerous streams which rise within its bounds flow in every direction. Both Whitewater and White rivers have their sources within the county, the tributaries of the former draining the southern third and those of the latter the central third, while across the northern third flows the Mississinewa, which is also fed by numerous small streams.

The soil of the county is, for the most part, a heavy clay enriched by the vegetable accumulations of ages. The clay, being of drift origin, is composed of the debris of many different formations which contain all the elements necessary for plant food. Wheat, corn and grass are the leading productions; the cereals and live stock furnishing the principal income of the agricultural classes.

The county is supplied with the best of transportation facilities. Two divisions of the Big Four Railway cross it from east to west, one near its center, the other across the southern third. The G. R. & I. bisects it from north to south and the P. C. C. & St. L. cuts across its northeastern fourth, while the C. C. & L. touches its

southwestern corner. The Dayton & Muncie Traction Line also connects Union City, Winchester, the county seat, and Muncie, Delaware County.

The highest land in Indiana is on the middle ridge near Bloomingsport, on the "Summit" between Greens Fork and Martindale Creek, where the elevation on the Peoria Division of the Big Four has been found to be 1,234 feet above sea level. Some of the hills south of this point are estimated to be 50 feet higher, so that 1,285 feet is approximately the highest level in the State. The elevations of the principal railway stations in the county are as follows: Carlos, 1,208; Crete, 1,181; Deerfield, 1,004; Farmland, 1,037; Harrisville, 1,101; Johnson, 1,177; Losantville, 1,128; Lynn, 1,162; Modoc, 1,174; Parker, 1,023; Ridgeville, 982; Saratoga, 1,044; Snow Hill, 1,174; Stone, 1,034; Union City, 1,102; Winchester, 1,089; Woods, 1,083.

But a small portion of the western half of Randolph County has as yet yielded oil in any quantity. In 1903 a number of big wells were brought in just northeast of Parker, one of which started at 420 barrels, and averaged more than 300 barrels a day for four months. This led to extensive drilling in that vicinity, and the development of some 15 to 20 square miles north of Parker, in Green and Monroe townships, and south in Stony Creek township. The territory, however, proved to be very spotted, 39 per cent. of the bores in 1903, 24 per cent. in 1904 and 42 per cent. in 1905 proving wholly barren. In the past year a number of leases have been abandoned, while the output of all the wells was greatly diminished.

Outside of this Parker pool but few isolated producing wells have been drilled in the county, and they have been very light in output.

Jackson Township (21 N., 15 E.).—In this township, which lies in the northeastern part of the county, adjacent to the Ohio line, several small producers have been finished in recent years. Two of these, on the Clough lease, northeast quarter of section 9 and northwest quarter of 10, were sunk 285 feet in Trenton, but got oil only in the upper pay and started at about 20 barrels each. Three or four others were drilled on the southwest quarter of section 3 and the southeast of section 4, about 15 miles southeast of Portland, and near the town of Jordan. One of these started at 50 barrels. About 1,200 barrels of tankage was filled and a pipe line put in from the Ohio production to the east. Three of these wells are yet pumping. Other bores just to the west developed gas only, one or

two showing a rock pressure of 300+ pounds and a volume of 1,250,000 feet. The top of Trenton occurs at 1,065 feet and the gas and oil about 20 feet lower.

A test bore on the northwest quarter of section 6, near Pittsburg, started at 30 barrels and filled two tanks. A second bore on the same lease resulted in a dry hole and the company went bankrupt.

Ward Township (21 N., 14 E.).—Only two or three sections in this township have been tested. On the Huber farm, northwest of 15, one mile northeast of Deerfield, three light producers have been drilled, but on account of lack of pipe line are not operated. The record of No. 3 showed:

	Feet.
Drive pipe	37
Casing	250
Top of Trenton	975
Oil	993
Total depth	1030
Initial output, barrels	10

Two small producers, which have since been abandoned, were also finished on the Fitzmartin tract in the southwest of section 10. A light well has also been drilled on the Warren farm in the northwest quarter of section 25, one mile north of Saratoga.

White River Township (Parts of 20 N., 14 E., and 20 N., 13 E.).—This is the township in which Winchester, the county seat, is located. The only bores which have produced oil in any quantity within its bounds are on the Pickett and adjoining tracts in the southwest quarter of section 23, two miles east of Winchester. Here six bores were sunk in 1903 to 1905, one of which started at 100 barrels. A pipe line was put in and several thousand barrels of oil produced, but dissension broke out among the members of the operating company and the wells were closed down in the fall of 1905 and have not since been operated. Five of them were yielding a total of 20 barrels per day when shut down. The power house and six 250-barrel tanks are yet in place. The top of Trenton is here found at 1080 feet and the oil 30 to 35 feet lower.

A bore on the Benson tract in the north half of section 15 was sunk 514 feet below the top of Trenton, passing entirely through that formation. The total depth was 1594 feet, and it developed only a small amount of gas.

A number of gas wells in 29 and 30 and adjoining sections, southwest of Winchester, have made quite a showing of oil, but have not been drilled deep enough to fully develop their capabilities of yield.

A test on the A. Brown lease, six miles southeast of Winchester, which developed a light showing of oil and some gas, had the following record:

	Feet.
Drive pipe	227
Casing	335
Top of Trenton	1113
Total depth	1214

Monroe Township.—This civil township comprises a part of four different congressional townships and the numbers of the sections are, therefore, very confusing. It embraces the south halves of sections 29 and 30 and all of 31 and 32 (21 N., 13 E.); sections 5 to 8 and 17 and 18 (20 N., 13 E.), the south halves of sections 25 to 29, and all of 32 to 36 (21 N., 12 E.), and sections 1 to 5 and 8 to 17 (20 N., 12 E.).

More oil has been produced in this township than in all the rest of Randolph County, but in the last two years the new developments have been few and the output has greatly diminished. Most of the producing territory is in the three western tiers of sections.

On the J. F. Wood tract in the southeast quarter of 28, three or four bores were sunk during the year, two of which were dry. The Cowgill tract, in the southeast of 29, developed three light producers during the year and was the only new territory added in the township. Two dry holes and a gas well were completed on the Huston lease in the north half of section 8. The east half of section 9 is yet the best in the township, No. 11 on the Jones lease in the northeast quarter starting at 187 barrels and No. 12 at 75 barrels.

Several good wells were also completed on the Barnard tract in section 16. No. 2, when shot at 270 feet in, was thought to be dry, but was drilled to 300 feet and re-shot, when it started at 100 barrels.

Greene Township.—This township comprises 31 square miles and lies just north of Monroe township. Only four or five sections in its southwestern corner produce oil in commercial quantity, and the wells in these are light. The only bore sunk in the township in 1906 was a dry hole on the C. Reed tract in the northwest of 29.

Stony Creek Township.—This township lies just south of Monroe on the western side of the county. A number of bores have been put down within its bounds, but they, for the most part, resulted in very light wells or dry holes. Some of the more lightly produc-

tive which have been abandoned were on the McIntire lease in the southeast of 19 and on the Knobe farm in the northeast of 30.

On a tract of 1,200 acres, leased by the Parker-Marion Oil and Gas Company, part in Perry township, Delaware county, but mostly in Stony Creek township, eight test bores were sunk, all of which were practically dry holes. The company bought the leases, paid rentals for two years, spent, in all, more than $20,000, and got nothing. The record of one of the dry holes on the Thornburg lease, in the southeast corner of section 32, Stony Creek township, may be taken as the average. It showed:

	Feet.
Drive pipe	64
Casing	320
Top of Trenton	956
Total depth	1307

Five of the other dry holes were located as follows: One just south of Windsor; one in the northwest quarter of section 32, Stony Creek township, one in the southwest corner of section 4, in the extreme southeastern corner of the tract, and one in the northeast quarter of section 1, Perry township. One bore on the Swingley lease, in the northwest of 33, Stony Creek, started at about five barrels per day, the oil being found in the upper pay.

No bores were sunk in the township during 1906. The only wells now pumping are some very light ones in the west half of section 21.

DELAWARE COUNTY,

comprising an area of 395 square miles, lies east of Madison, north of Henry, south of Grant and Blackford and west of Randolph and Jay counties. Its soil is of drift origin and very diversified, but is, for the most part, noted for its fertility. White River crosses the county from east to west, a little south of the center, and together with its tributaries drains the southern two-thirds. The Mississinewa, flowing in a northwesterly direction, crosses the northeastern fourth and, with its tributaries, furnishes ample drainage for the northern third.

The transportation facilities of the county are most excellent. The Cleveland division of the Big Four, the Lake Erie and Western, the Chicago, Cincinnati & Louisville, and the Ft. Wayne, Cincinnati & Louisville, all intersect at Muncie, the county seat, and from that point diverge in all directions. Besides these, the Chicago, Indiana & Eastern, from the northwest; the Central Indiana

from the west, and five interurban traction lines, two running west, one north, one northeast and one east, have their terminals in Muncie.

The elevations in feet above tide of the more important railway stations in the county, are as follows: Albany, 939; Cammack, 931; Daleville, 910; DeSoto, 956; Eaton, 910; Gilman, 901; Muncie, 950; Oakville, 1,008; Reeds, 929; Royerton, 928; Selma, 1,005; Shidelers, 911; Yorktown, 924.

Petroleum was first produced in Delaware County, near Gaston, Washington township, in 1897. Several bores on the W. H. Broyles lease in section 36 produced large quantities of both gas and oil. On account of the waste of gas the wells were soon shut down by injunction. The gas pressure in that part of the county has since, for the most part, been too high for the production of oil.

In 1901 and 1902 a number of producing wells were drilled in the shallow sand in Delaware, Liberty and Center townships, north and east of Muncie. Several of these came in as large producers, and while the most of them have been abandoned, a number of the best ones are still yielding.

In the latter part of 1903 a bore on the Michaels lease, in the northeast quarter of section 15, Delaware township, passed through the shallow sand, in which the oil had heretofore been found at a depth of about 50 feet in Trenton, without finding either gas or oil; but at a depth of 270 feet in Trent, struck a pay sand which yielded 160 barrels per day without shooting, and for 35 days pumped natural an average of 70 barrels per day. This was the beginning of what is known as the "deep pay" drilling in Delaware county, which caused the famous oil boom of 1904, during which year the county went to the front as an oil producer. In that year 831 producing wells were drilled in the county with an average initial production of 44.4 barrels. However, in finding the approximate bounds of the productive area, 121 dry holes were drilled during the year. Many of the productive wells were sunk too deep. They were drilled through a second pay in search of a third, and got salt water instead of oil.

During the year 1905 many of the best producers were drowned out, while the output of all was largely diminished. By the first of January, 1906, nearly forty of the forty-nine oil and gas companies of 1904 had gone to the wall. A number of these were stock companies which depended on the boom to aid them in disposing of their gilt-edged certificates to gullible buyers. They were the first to close up, as their promises on paper could not be kept. But

few companies made any money in the deep pay field, and such as did were, for the most part, composed of men from the East, who got hold of large leases, partly developed them, and then sold for a good price before the heavy body of salt water made its appearance.

In general, the oil in the deep pay wells in Delaware County is found between 270 and 300 feet in Trenton. An occasional bore is sunk as low as 350 feet in, but they are poor producers. Sometimes what is known as a "stray pay" is found at 150 to 200 feet. The bores in which they occur make quite a showing for a few days, but soon drop to little or nothing. The average deep pay well holds up better than the more shallow ones, a 250-barrel one yielding about 50 barrels at the end of six months. But little gas is now developed in the bores sunk in the county, and drilling is in many places done with Hocking Valley coal.

The oil from the deep pay wells is a little heavier than that from the more shallow ones, and has a tendency to hold together with water, so that most tanks have to be steamed. It is said to be a higher grade product than any other Indiana oil, but the Standard does not recognize that fact and pays the same per barrel as for South Lima. The average deep pay well is shot with 160 quarts of nitro-glycerine. The "sand" or pay streak usually runs from eight to ten feet in thickness, but in some of the best wells occurs 30 to 50 feet thick.

Much of the territory now marked light and fair on the accompanying map was high grade in 1904 when first developed, but has since fallen down greatly in output.

During the year 1906 but little new territory was added to the productive area in Delaware county. In the southwest part of Delaware and the southeast part of Hamilton townships several sections before untested have yielded a number of good wells, while in other parts of the county a number of leases formerly productive were abandoned. The oil map shows the relative value as well as it could be ascertained, of the productive area on January 1, 1907.

Liberty Township (Sections 31 to 36, 21 N., 11 E., and 1 to 25, 20 N., 11 E.).—This township has included the most productive oil territory in Delaware County. The large majority of the deep pay bores sunk in 1904 and 1905 were within its bounds. At one time nearly every section could be classed as fair to good territory, but several of them have been wholly abandoned, while a number of others are only light producers.

In section 36, in the northeast corner of the township, the new wells of the year started only at 15 to 25 barrels, as against 100 to

500 in 1904. Several leases in this section have been abandoned. It was on the Jas. Baughn farm in the southwest quarter of this section that the banner well of the State for the year 1904 was drilled. It is said to have started at 800 barrels and to have filled forty 250-barrel tanks in the first two weeks. From the time the first oil was struck at 1,181 feet to the bottom, a distance of 32 feet, the drill passed through a very porous brown limestone or pay streak. No shallow or top pay occurs in this part of the township.

The northeast quarter of section 35 was abandoned after four or five wells had been sunk, while bores on other parts of the section have resulted mostly in dry holes or light producers. Sections 34 and 33 are undeveloped, while 32 and 31 have only dry holes or abandoned light territory to their credit.

The northwest quarter of section 1, Liberty township, was a part of the famous Mt. Pleasant pool, opened up in 1904, but the remainder of the section has been non-productive or very light in output. In the southeast quarter of section 2, No. 9 bore on the Hitchcock lease started at 75 barrels in January, 1906, while Nos. 1 to 7 on the same lease were pulled in October, as were also five wells on the Stephens farm just to the west.

On the Swander lease in the northwest quarter of the section, the average record of three light producing wells showed:

	Feet.
Drive pipe	100
Casing	350
Top of Trenton	935
First oil	1195
Total depth	1201

Here, as elsewhere in the deep pay, much water has to be pumped to secure the oil.

A dry hole was bored in the northwest quarter of 3, but the remainder of the section is fair to good territory, two wells on the Shroyer lease, northeast quarter, starting at 180 and 100 barrels, respectively. Sections 4 and 5 have produced gas only, while several light wells in the northwest of 6 have been recently abandoned. The north half of section 7 is undrilled, while the wells on the south half, formerly light producing, have been pulled.

The county farm of 240 acres in the southeast quarter and the east half of the southwest quarter of section 8, has proven one of the best leases in the Muncie field. Of the 33 bores sunk on it, only two or three have come in dry, while six have been abandond. On November 1, 1906 there were, on the farm, 21 producing wells yield-

ing a total of 75 barrels per day. The total production up to that time had been 133,398 barrels, from which the county had received $20,000 in royalty.

Just to the west of the county farm the Ohio Oil Company paid $10,000 bonus for 126 acres. All the wells sunk on it were light and the lease has been abandoned.

Section 9 has yielded some good producers in the south half, while the north portion is much lighter. The Burt Oil Company, composed of Muncie business men, sunk twelve bores to the deep pay on 60 acres in the southwest quarter of the section, and paid 65 per cent. on $20,000 capital in less than a year. One of the bores was a "freak" or crevice well, which started at 400 barrels, and was down to nothing in three months. The eleven producing wells were yielding 20 barrels a day in October, 1906. A record of No. 11, finished February 3, 1906, shows:

	Feet.
Drive pipe	114¼
Casing	330
Top of Trenton	894
First oil	1173
Total depth	1177½
Initial output, barrels	240

The bore was sunk but 4½ feet into the pay in order to avoid the salt water.

A bore on the Neal lease in the southwest corner of the section produced quite a quantity of gas in the second, or deep pay, which is quite unusual at that depth. The top of Trenton is struck at 895 feet on this lease. Another bore on the same lease started at 320 barrels and was down to 25 barrels in six months.

Sections 10 and 11 have proven very spotted territory. None of the recent wells have come in at over 40 barrels, while several leases formerly productive have been abandoned. Most of the production in sections 12 and 13 is from the shallow pay, the deeper sand yielding salt water or nothing. The new wells of the year started at 10 to 20 barrels each.

The Black and L. Winget leases in section 14 have proven very productive from both the shallow and deep pays. The former lease of 80 acres yielded over 80,000 barrels, but has been, for the most part, drowned out and in part abandoned. The 10 wells yet remaining were producing a total of 35 barrels daily in October. The remainder of the section has been only fairly productive, two of the recent bores on the W. Dunkin lease in the southeast quarter coming in dry.

The greater part of section 15 has been abandoned. Most of the wells were drilled too deep and though a number of them were at first fair producers, the salt water soon drowned them out. The Clark lease in the southwest quarter was a fair example. Eight wells were drilled on 90 acres and when pulled the operating company had lost $11,000 on the venture.

The north half of 16 produced during the year a number of fair to good wells, but those on the south half came in light, and several of the leases were abandoned. On the Burt lease of 54 acres in the northwest quarter of 17 there are 14 producing wells, several of which started at 100 barrels or more. The remainder of the section is only fair to light in production. The Daniel Boone Company has been fortunate with its holdings on the Guthrie lease in the northeast quarter of 18, but it has recently begun to show salt water in quantity. The Heaton lease, southwest quarter of the same section, has been abandoned. The remainder of the section is light in output.

The greater part of the west half of 19 has been abandoned, while the remainder is light, but 20, to the east, is yet fair to good. The top of Trenton on the Cecil and Truitt leases in the south half of 20 occurs at 925 feet. In 1904 this ranked as among the best territory in the Muncie field and it has since held up well, the new bores in 1906 starting at 40 to 130 barrels. The south half of 21, where some of the best producers in the deep pay were located, has fallen to a fair standard, with an occasional dry hole. A pumping station is located on the northeast quarter of this section from which most of the oil of Liberty township is piped to Montpelier, Indiana.

All of the leases in section 22, where, in 1904, was located the famous Smithfield town lot pool, have fallen off greatly in production. Not one of the 40 producers of the hamlet, in June of that year, is now pumping, and several of the leases to the west have also been abandoned. The once famous Lewis lease is still operated, but can only be graded as fair territory. The north half of 23 continues productive, though two of the 31 wells sunk on the Cecil lease have been abandoned and one dry hole drilled on the south side. A record of No. 20 may be taken as an average, and shows:

	Feet.
Drive pipe	109
Casing	305
Top of Trenton	933
First oil	1169
Second oil	1207
Total depth	1213

The wells south of White River, which crosses the center of the section, yield a little more water and are less productive.

The north half of 24 may yet be regarded as fair territory, but the south portion is light, several of the new wells starting at 2 to 15 barrels each. No. 8, on the Naylor lease, which came in as a light producer, showed:

	Feet.
Drive pipe	105
Casing	308
Top of Trenton	970
Gas showing	980
First oil	1242
Total depth	1242½

The only production in section 25 is on the Odle lease in the northwest quarter, and there is no yield east of that quarter section. To the west, in 26, the Cline lease has a number of fair wells. No. 14, drilled in August, started at 250 barrels, while No. 15, in September, was dry. A test bore on the School farm, in the northeast quarter, was light and abandoned. The northeast quarter of 27 contains a number of fair producers. On the Williams lease ten wells were making about 30 barrels a day, in October. One of these came in at 150 barrels and held up to 100 barrels for several months, while only 200 feet away, another bore started at only four barrels. The southwest quarter of the section has been recently abandoned. Section 28 is now light or abandoned territory. The Dunkin lease in the east half of the northeast quarter was, in 1904, one of the better grade deep pay farms, but has been mostly drowned out, while the Williams, just west, has been abandoned. On the Howell lease of 80 acres, in the south half of the section, three good wells and one old gas well were located in March, 1905. The lease was making a tank a day and sold at that date for $27,500. The new owners put down four bores on the west side of the lease, all of which were very light producers. In this case the slump in value was due to absence of the article sought.

In the west half of section 29 the once productive Collins lease has, in part, succumbed to salt water, and several of the wells have been abandoned, as has also the Reese farm to the north. The remainder of the section is fair to light territory. Section 30, most of which was light producing territory in 1904 and 1905, has been wholly abandoned.

A number of sales of property in Liberty and adjoining townships were made during the year. The largest of these, consum-

mated in December, 1905, was that of the holdings of the Republic Iron and Steel Company to the Ohio Oil Company. The property consisted of leases on several thousand acres of gas and oil territory and above 325 producing wells. The leases were all finely equipped, and in 1904 had the largest output of any company in the field; the Lewis farm in section 22 and the Cecil and Collins leases in 20 and 29, Liberty, being the cream of the territory. Up to the time of the sale the Lewis farm of 177 acres had yielded 500,000 barrels of oil. In June, 1904, the property of the Republic Company was estimated at $1,100,000, but due to the slump in value of all deep pay property, the selling price was only about one-half that sum.

The Commonwealth-Jewell Oil Company sold several hundred acres of leases and 90 producing wells, in November, to Claud A. Ulsh of Rising Sun, Ohio, for $65,000. These wells were mostly located in the northeast portion of the township and comprise a part of the Mt. Pleasant pool, which yielded so freely in 1904. The Norton Oil Company bought about the same time 220 acres, embracing the Lennon tracts in sections 21 and 22.

Liberty township will continue to produce oil for a number of years, as new wells are continually being sunk on leases already in operation. However, the output will gradually decrease, as more wells are being abandoned than are being drilled, while those now pumping are slowly failing, as is always the case when a stored product is being drawn upon.

Perry Township (Sections 31 to 36, 20 N., 11 E., and sections 1 to 25, 19 N., 11 E.).—This township lies just south of Liberty and below the area shown on the accompanying oil map. The only production within its bounds has been in the northern half. Most of the bores resulted in light wells or dry holes.

In the northwest quarter of section 32, two or three light wells were sunk on the Markley and Whitney leases, but these have been pulled. Several dry holes were bored in the northeast quarter of the section. In the north half and the southwest quarter of 33 were also several light producers, now abandoned. The northeast quarter of 34 has two or three light wells to its credit; as does also the northwest of 35, these being at present the only producers in the township. A bore on the Will lease in the northeast quarter of 36 was dry.

In the second and third tiers of sections some light producers were drilled in the north half of section 4, and also in the southwest quarter of section 8, but these have all been pulled.

Center Township (Sections 31 to 36, 21 N., 10 E., and Sections 1 to 25, 20 N., 10 E.).—But little producing territory has been developed in this township, in which the city of Muncie is located. Test bores have been sunk upon ten or a dozen sections, but all but one or two resulted in light wells, which have been abandoned, or in dry holes. The most of the oil was found in the shallow pay.

Northeast of Muncie, in the north half of section 36, three or four bores were sunk in the early history of the field, which were light or dry. As there was no gas with which to operate, the leases were abandoned. The greater part of the section was afterward leased by the Ohio Oil Company, and several light wells drilled on the southeast quarter. A bore sunk in 1906 on the Sears lease in the north half was dry.

All the bores drilled to shallow pay in sections 1 and 2 have been abandoned. One of these, on the McGalliard farm, north half of the southwest quarter of 1, created much excitement in the early history of the Muncie field by starting at 12 barrels an hour and making 1,800 barrels in seven days. In it the top of Trenton was found at 969 feet. A bore drilled to deep pay on the Richison lease in the southeast quarter of the section came in dry in May, 1906. The north halves of sections 11 and 12 at one time contained several light wells, but all have been abandoned. Several light wells on the southeast of 13 and the north half of 14 have also been abandoned, while a few in the northeast quarter of section 24 are still pumping.

Mt. Pleasant Township (Sections 1 to 30, 20 N., 9 E., and 1, 12, 13, 24 and 25, 20 N., 8 E.)—But few test bores have been sunk in this township, which lies west of the city of Muncie. Two light producing oil wells were drilled during the year on the O. Williamson lease in the northeast quarter of 14, and one on the H. E. Gilbert farm in the southeast quarter of the same section. An excellent gas well was finished near Yorktown in November, on the J. K. Campbell farm, in the southeast quarter of 23.

Hamilton Township (Sections 1 to 30, 21 N., 10 E.)—The only producing territory in this township is in the eastern three tiers of sections. The first producing wells were sunk in 1904, on the J. G. Lefler farm of 80 acres, in the northeast quarter of section 22, near the town of Royerton. They were put down to deep pay, and one of them came in at 60 barrels while another was a dry hole. Two additional bores were sunk in 1905, both of which were light producers. The lease has since been abandoned. In the four bores the top of Trenton was struck at the following depths:

	Feet.
No. 1 in the southeast corner	960
No. 2 in the northwest corner	914
No. 3 in the northeast corner	935
No. 4 in the northwest corner	910

As the surface levels differed but little, the top of the Trenton is seen to be very uneven.

Several good wells were sunk on the McCullough lease, in the south half of section 24, in the year 1905. One of these started at 180 barrels and led to extensive drilling in the vicinity, which resulted, during the year 1906, in a number of fair to good wells and one dry hole, the latter being in the southeast corner.

The greater part of section 1, in the northeast corner of the township is fair territory. Eleven bores have been sunk on the Burt lease which started at ten to 80 barrels each. A dry hole and two or three light producers were sunk on the Beal farm in the northeast quarter of section 3, while another dry hole was put down just north, in the southeast corner of 34, Union township.

The northeast quarter of 12 is light territory, while the northwest of 13 grades higher. The southeast of 13 is light, while dry holes were sunk in the southeast of 15, on the Stradling and Smith leases, just west of Royerton, in which the top of sand was found at 935 feet.

Other deep bores which were barren of production have been sunk in the west half of the township on the following tracts:

W. A. Bell, southwest quarter section 7, through Trenton.

M. J. Cummings, southwest quarter section 16, 385 feet in Trenton.

M. B. Cooley, northeast quarter section 20, 350 feet in Trenton.

On the Bell lease the Trenton was 476 feet in thickness. Just below it was a blue shale 20 feet thick, which merged into a sandstone with an abundance of salt water.

The best production in Hamilton township is on the three sections 24, 25 and 26, in the southeast corner. The Norton Oil Company, in May, 1906, bought of Riley Allen 460 acres of leases in the east half of 23, the northwest quarter of 24 and the north half of 25, together with 180 acres just to the east in sections 19 and 30, Delaware township. When sold the property had on it 25 oil and two gas wells, which had produced an average of 110 barrels per day for three months. The price paid was $500 per barrel, or $55,000, a very low figure. Six additional wells were

sunk during the summer, which brought the production up to 150 barrels daily by October 15th. Three of the best of these were on the Payton lease, in the northeast of section 25, where Nos. 9, 10, 11 and 13 are said to have been started at 200, 200, 140 and 150 barrels, respectively. The records of No. 9 and of No. 10, 500 feet south, showed as follows:

	Feet. No. 9.	*Feet.* No. 10.
Drive pipe	29	34
Casing	332	330
Top of Trenton	927	933
First oil	1215	1222
Total depth	1220	1226

The gas wells yield an abundance of fuel, and it was stated that on this account the oil could be produced for 12½ cents per barrel, which is thought to be the most economic production in Delaware County. The ten wells on the Payton lease were producing 65 barrels a day in November.

The east half of 23 is as yet untested. On the Wilson Heirs' farm in the southeast quarter of 25, six bores were sunk during the year which started at 300, 100, 18, 180, 40 and 50 barrels each, respectively. One bore on the Kaufman lease in the northeast quarter of the same section started at 125 barrels, while a second, one location away, was wholly dry.

Delaware Township (Sections 1 to 30, 21 N., 11 E.).—The first producing oil well sunk in this township was finished in 1901, on the Krohn farm, southwest quarter of section 11, and a mile southwest of the town of Albany. Trenton rock was struck at 925 feet and penetrated 50 feet. The bore yielded 60 barrels of oil and a large amount of salt water the first day it was pumped. This lease has since been abandoned. The first deep pay well in Indiana was finished November 3, 1903, on the David Michael lease, northeast quarter of 15 and a short distance southwest of the Krohn producer. Here a test bore started without shooting at 160 barrels, and for 35 days pumped natural 70 barrels per day. No oil was struck until the drill had pierced Trenton 270 feet. This big strike in territory hitherto unproductive and at so great depth in Trenton, caused much excitement among the oil fraternity, and by January 1st, 1904, five other bores were drilling on the same lease and four on adjoining tracts. One of these, located 800 feet north and east of the Michaels well, on the E. Black lease, southeast quarter of section 10, came in as a 100-barrel producer, and the deep pay production of Delaware County, in which a few

operators made money and a large number lost their all, was fairly started. The records of the Michael and Black wells were as follows:

	Michael well.	*Black well.*
	Feet.	*Feet.*
Drive pipe	40	27
Casing	370	310
Top of Trenton	920	921
Total depth	1195	1232

There is no production in sections 1 and 2 of Delaware township. On the Davis lease in the northwest quarter of 3, there are three small oil wells, while just south are two bores yielding gas and one oil. An average record shows:

	Feet.
Drive pipe	40
Casing	325
Top of Trenton	944
Gas	1010
Total depth	1200

The gas is found in upper pay only. A bore on the Current lease in the southwest corner was barren. The north half of section 4 was drilled to shallow pay in 1903 and yielded a number of fair wells and a dry hole in the southeast corner. The south half has only dry holes or light territory to its credit. The south half of section 5 has at present a light production, as has also the north half of the northeast quarter, the rest of the section being abandoned.

The greater part of 6 has had a light production, but it is now shut down and partly abandoned. In the northeast quarter of 7 five wells were sunk on the Stafford lease, three of which were drilled in 1905. One or two of them started at over 100 barrels a day, but in June, 1906, all five were making only six barrels daily. The power house soon after burned and the lease was abandoned. The record of these wells showed:

	No. 1.	*No. 2.*	*No. 3.*	*No. 4.*	*No. 5.*
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Drive pipe	103	152	96	101	118
Casing	310	320	335	316	330
Top of sand	884	925	940	913	907
Gas	....	....	....	925	920
First pay	1170	1218	1015	....	1195
Second pay	....	....	1239	....	....
Third pay	....	....	....	1202	....
Total depth	1190	1239	1251	1220	1218½
Initial production, bbls.	....	....	55	110	15

A bore on the Wingate lease in the southwest quarter started at 200 barrels. All of section 8 is light, while 9 has yielded only a number of barren bores. The north half of 10 has been for the most part abandoned, as most of the ventures of the year were dry holes. The south half is still producing fair wells. Almost all of 11 has been abandoned, the new bores being light or dry, while 12, 13 and 14 are yet untested.

On the Michaels tract in the east half of the northeast quarter of section 15, just west of where the first deep pay well came in, another bore, No. 8, started in July at 230 barrels, while on the Goings lease, west half of the northwest quarter, four good wells and one dry hole were drilled. Three dry holes were also drilled in the southwest quarter of 15, and one on the southeast quarter, thus showing the spotted nature of the field.

The dry hole on the north half of the Goings tract showed:

	Feet.
Drive pipe	30
Casing	347
Top of Trenton	935
First showing of oil	965
Second showing of oil	1200
Total depth	1203

Section 16 is as yet non-productive, dry holes having been drilled in the southeast and northwest quarters. The north half of 17 contains a number of fair wells, the Friddle, Marsh and Holloway leases being the best, one bore on the first mentioned tract having made eight tanks a month for several months. The west half of 18 is also fair, one bore on the Dick lease in the southwest quarter starting at 200 barrels. The east half of the section is lighter.

The spotted nature of the deep pay field has been well shown in this vicinity. The Ohio Oil Company put down a bore on the D. E. Brammer tract, southwest quarter of 18, which started at 175 barrels and when three months old made 40 barrels per day. No. 2, 500 feet south, started at only one barrel, while No. 3, 1,500 feet east, was absolutely dry. A bore 500 feet south of No. 3 was a 150-barrel producer, while another on the Dick lease, 700 feet to the east of this, was barren. In most territory one can hazard a guess as to the results of future bores but in the deep pay of Delaware township every bore is a gamble.

The southwest quarter of 19 has yielded a number of fair producers, while the remainder is light or untested. In section 21

the northeast quarter, formerly producing, has been abandoned. Section 22 has so far proven, for the most part, gassy or barren. No. 8, on the Dowell tract in the southeast corner, had the following record:

	Feet.
Drive pipe	50
Casing	325
Top of Trenton	942
First oil	967
Second oil	1232
Total depth	1237

In this and a number of wells in deep pay territory both pays are shot and pumped. The lower pay is first shot and cleaned out, then a squib is put in and the upper pay shot and cleaned. The oil from the upper pay then falls and is pumped from the bottom.

In section 23 a bore on the Richey tract in the southwest quarter started at 100 barrels, and at the end of 12 months was yielding seven barrels, which is above the average for a deep pay well of that age. The south half of the section yielded a number of fair wells during the year. On the Evans lease in the southeast quarter one started at 180 barrels in June, and was making six barrels in November. On the Pittinger lease, just north, No. 1 started at 130 barrels, while No. 2 was dry. The records of Nos. 1 and 2 Evans and No. 2 Pittinger were as follows:

	Evans No. 1.	*Evans No. 2.*	*Pittinger No. 2*
	Feet.	*Feet.*	*Feet.*
Drive pipe	41	49	30
Casing	335	323	350
Top of Trenton	921	927	932
Upper pay	939	952	....
Second pay	1198	1203	1201
Total depth	1207	1208	1227
Initial production, barrels	180	42	....

A big water well was drilled on the Pogue tract, south of the center of the section. In shallow pay such wells are often the best producers, but in deep pay the water increases and stops all production. Some operators put in their pumps a duplex barrel, by the aid of which they are enabled to handle twice as much fluid as with an ordinary barrel.

Section 24 has a number of fair producers on the southeast quarter, the southwest quarter being lighter. On the Bartlett lease, in the northwest quarter of 25, two fair wells and three dry holes

were sunk. On account of much water and no gas with which to operate, the lease has been abandoned. A dry hole was sunk during the year on the Lewellen lease in the southeast quarter. The remainder of the section is light territory.

A test bore on the F. D. Pittinger, west half of the southeast quarter of section 26, after striking the sand in deep pay, pumped a quantity of oil, then nothing but salt water for the first day. On the next morning it yielded a large quantity of oil for an hour, then went back to salt water and furnished but little oil for a month, when it was abandoned. It was at first thought to be a 100-barrel well. With the exception of another dry hole north of the center the remainder of the section is untested. Section 27 is very spotted. The Payton lease in the northwest quarter has two fair wells, while farther east are some light ones. All bores in the south half have been non-productive. The southeast quarter of 28 has several light wells to its credit, but the remainder of the section has proven dry or gassy.

Section 29 is as yet unproductive, but 30 contains some of the best territory in the township. The Wm. Reed farm, in the southwest quarter, has on it eleven wells, four or five of which started at more than 100 barrels each. The Shreve lease, just east, has been abandoned, while the north half is mostly fair.

While Delaware township has yielded some big producers, its area may be classed as among the most spotted in the Indiana field. Many good wells will yet be sunk within its bounds, but the man who drills them is taking a big chance for his money.

Niles Township (Sections 7 to 36, 22 N., 11 E.)—The first producing wells in this township were drilled in its central and southwestern portions in 1903. Most of its area has been tested, but only a few sections have proven paying territory, many of the test bores being barren. The following is a list of the dry holes in the non-productive sections as far as they could be secured:

Lease	*Location.*
Hughes	S. E. ¼ Section 8
Manor	N. E. ¼ Section 10
Manor	S. E. ¼ Section 17
Saunders	S. W. ¼ Section 20
Manor	N. E. ¼ Section 20
Motlen	S. E. ¼ Section 24
Wingate	N.W. ¼ Section 26
Wingate	S. E. ¼ Section 27
Williams	N. E. ¼ Section 33
Gregory	S. W. ¼ Section 34

There are some light producing wells on the southeast quarter of section 15 and the northeast quarter of 22, but none farther east in the north half of the township. Besides the dry holes mentioned above as having been drilled on section 20, the southeast quarter of that section contains five light wells and a dry hole, the records of the producers showing:

	No. 1.	*No. 2.*	*No. 3.*	*No. 5.*	*No. 6.*
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Drive pipe	138	203	222	138	284
Casing	330	307	300	300	312
Top of Trenton	954	959	955	959	960
First pay	1262	1260	1260	1265	1267
Total depth	1297	1300	1290	1305	1305
Initial production, bbls.	....	....	45	20	3

The north part of section 21 is better, several wells in the northeast quarter having started at 90 barrels or more during the year. Farther east, near the Jay County line, there are several light producers in the deep pay on the Bales and Gray tracts, in the north half of section 25.

The best lease in the township has been that of the Racer Oil Company, on the J. E. Racer lease of 22 acres, in the southeast of the northwest of section 28. Seven bores were put down on the farm, six of which were producers, yielding 60,000 barrels in three years, and doing 20 barrels per day in November, 1906. The lease was recently sold for $10,000.

The Miller, Barley and Eaton leases in the same section also contain a number of fair wells. In them the top of Trenton occurs at about 960 feet and the deep pay, in which most of the oil is found, at 1,215 feet. Leases aggregating 160 acres with six producing wells were sold in this section for $4,000 in 1906. For the same property $32,000 was refused in the fall of 1904.

Only the east half of section 29 is productive, the Clark lease in the northeast quarter and the Bosman in the southeast being the best. On the Clark lease four bores have been sunk, the record of No. 4 being:

	Feet.
Drive pipe	36
Casing	340
Top of Trenton	932
Gas	947
Oil	1244
Total depth	1264
Initial production, barrels	10

Sections 35 and 36, north and northeast of Albany, produce gas only.

Union Township (Sections 7 to 36, 22 N., 10 E.)—In 1904 and 1905 some oil was produced in sections 14, 16, 17, 20 and 22, near the central part of this township, but none of the wells are at present being pumped, and in November there was no production in the township.

A bore on the southwest quarter of section 18 came in wholly barren, after being sunk 500 feet into the Trenton. Other dry holes were put down on the Young lease in the southwest of 21; on the Barley lease in the northeast of 24; on the Hartle in the northeast of 33; on the Taylor in the southeast of 34, and on the Peterson, in the southeast quarter of 36.

Washington Township (Sections 7 to 36, 22 N., 9 E., and 12, 13, 24, 25 and 36, 22 N., 8 E.)—The first wells sunk in this township, those on the Broyles farm in the northeast quarter of 36 (22 N., 8 E.) have been abandoned on account of gas pressure. The most of those in the north half of section 12 have also been pulled out. At present there is no production in the township.

From what has been written it will be seen that the oil industry in Delaware County during the year 1906 was at a low ebb. The number of new bores fell off greatly, while the percentage of dry holes and abandoned wells increased. While the county will doubtless produce a large quantity of oil for a number of years, the industry will never again be as important as it was in the long to be remembered year of 1904.

Isolated Areas Producing Trenton Rock Petroleum Outside the Main Indiana Field.

In Wabash County.

For a long time the only productive area in this county was in Noble township, on the west side where, in the vicinity of Kellar's Station or Rich Valley, a number of wells have been yielding oil since 1897. The output was never large and a number of those first producing have been abandoned. The gas supply for fuel is very light and power for pumping is now in part supplied by the Fort Wayne and Wabash Valley Traction Company, whose line passes through the pool. No new bores were sunk in 1906, and at the close of the year there were 28 producing wells in the pool.

In Liberty township, which is in the southeastern part of the

county and near producing territory in Grant and Huntington counties, a well was drilled for gas in 1903 on the Scott tract in the southwest quarter of section 34. It showed a little oil, and in July, 1905, was drilled 40 feet deeper and shot, when it started at 25 barrels and made seven and a half barrels after 30 days' pumping. The original record was as follows:

	Feet.
Drive pipe	202
Casing	470
Top of Trenton	945
Total depth	965

A second well was drilled one location east on the same tract in the fall of 1905, and in October, 1906, the two were said to produce eight barrels per day.

Two miles east, on the J. S. Davis lease in the southeast quarter of section 36, two small producers were finished in 1906, while another was completed on the Miller tract in the same section. A test bore on the Daugherty tract one mile east of Treaty, in the southwest quarter of section 5, was put down 500 feet into Trenton, but produced only salt water. Liberty township at present furnishes part of the gas for the city of Marion.

In Miami County.

The Peru oil field which created such a furore when opened in 1897, is practically a thing of the past. It was, in the main, a "town lot" development and the derricks on Flax Hill in places stood so thick that, in some instances, they had only a board fence between them. Thirty or more companies were drilling at one time within the city limits and a number of them finished as many as five wells and never sold a tank of oil. The rock was very porous and some of the wells were big producers, but so many on so small an area soon drained the reservoir. Of the 356 which were sunk, but 16 are still in operation, twelve being abandoned in 1906, while but one, No. 3 on the N. Bruck lease, was completed. It had an initial output of but 15 barrels. The 16 producers were yielding about 1,430 barrels per month.

The best well in the Peru pool, that on the Artis lot, started at 400 barrels a day and is still making five to six barrels. But two or three of the first companies in the field made any money, and more than a quarter of a million dollars was sunk by the unsuccessful ones. For a time the boom added much to the prosperity of

Peru, as that sum was mainly put in circulation among its inhabitants.

A new pool was opened up in Erie township, three miles east of Peru, in 1898, which for a time had a vigorous growth, but its limits were soon defined and no new territory in that vicinity has recently been found. Four of the old producing wells were abandoned in 1906 and no new ones drilled, and at the end of the year there were but three producing in the township.

A bore sunk to the depth of 966 feet on the Milton Dougless farm northwest of Converse in September, 1906, developed a good showing of oil and 175 pounds of rock pressure of gas. A number of old gas wells in the vicinity have also been showing oil for some time, so that the region offers some inducements to prospectors. The well is in the southeastern part of Miami County, not far from the western line of Grant County.

*In Hamilton County.**

The oil development in Hamilton County is scattered in small pools; the two of main importance being in sections 1 and 2 (17 N., 5 E.) and 35 and 36 (18 N., 5 E.), Fall Creek township, and in sections 13, 23 and 24 (19 N., 3 E.), Washington township.

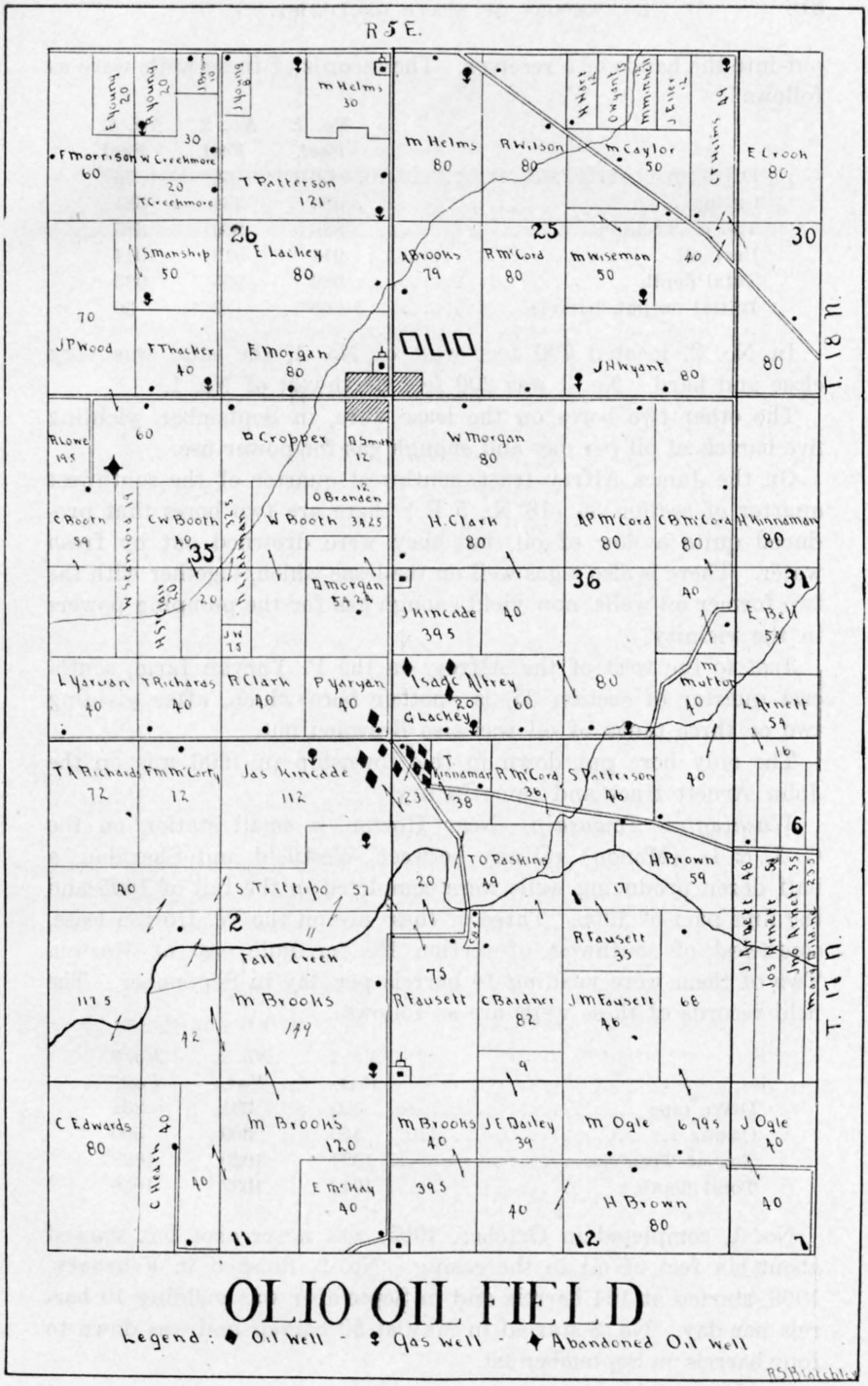
The early gas drilling showed the presence of oil in these pools and after the abandonment of the gas leases, wildcatting resulted in a few light to fair producing oil wells.

Fall Creek Township.—In this township, which is in the southeastern corner of the county, the first producing wells were drilled about one mile south of Olio in 1901, and a few others each year to 1905.

On the Kinnaman tract in the northwest quarter of the northwest quarter of section 1 (17 N., 5 E.) there are five wells, three of which were pumping in September, 1906, the total output of the three being about seven barrels per day. The top of Trenton is found at about 900 feet and the best oil at about 918 feet.

On the Kincade tract in the northeast of the northeast of section 2 there are five wells, three of which, completed in the spring and summer of 1905, were producing up to January 1, 1906, when they were closed down on account of the operating company being

*The data for this county was gathered and the maps drawn by R. S. Blatchley.



OLIO OIL FIELD

Legend : ● Oil Well - ● Gas Well - ✦ Abandoned Oil Well

RS Blatchley

put into the hands of a receiver. The records of these wells were as follows:

	No. 1.	*No. 2.*	*No. 3.*
	Feet.	*Feet.*	*Feet.*
Drive pipe	56	64	54
Casing	380	384	381
Top of Trenton	886	889	885
Best oil	914	918	914
Total depth	926	955	935
Initial output, barrels	65	2	50

In No. 2, located 700 feet west of No. 1, the sand was very close and hard. No. 3 was 200 feet northwest of No. 1.

The other two bores on the lease were, in September, yielding five barrels of oil per day and enough gas for power use.

On the James Alfrey tract, southwest quarter of the southwest quarter of section 36 (18 N., 5 E.) there are two bores that produced quite a flow of oil, but they were drowned out by fresh water. There is also a gas well on the lease which, together with the two former oil wells, now yield enough gas for the pumping powers in the vicinity.

Just to the west of the Alfrey, on the P. Yaryan farm, southeast quarter of section 35, is another bore which, after yielding two or three tanks of oil was also drowned out.

The only bore put down in this township in 1906 was on the John Arnett tract and came in dry.

Washington Township.—Near Horton, a small station on the C. I. & L. (Monon) railway between Westfield and Sheridan, a half dozen producing wells were completed in the fall of 1905 and the first part of 1906. Three of these are on the W. Horton lease, southwest of southwest of section 13, one mile east of Horton. Two of them were yielding 14 barrels per day in September. The field records of these wells are as follows:

	No. 1.	*No.* 2.	*No.* 3.
	Feet.	*Feet.*	*Feet.*
Drive pipe	305	231	234
Casing	560	500	500
Top of Trenton	1024	1020	1022
Total depth	1042	1037	1050

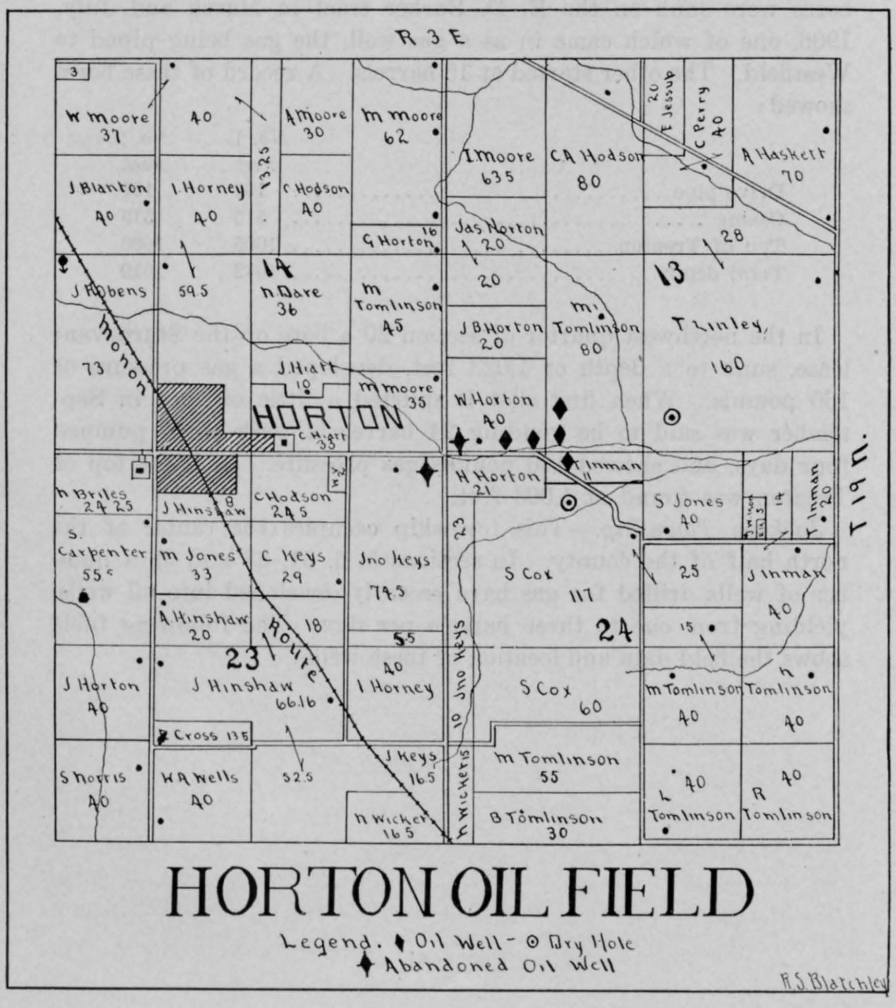
No. 1, completed in October, 1905, was never shot but showed about six feet of oil in the casing. No. 2, finished in February, 1906, started at 164 barrels and in September was yielding 10 barrels per day. No. 3 started in May at 50 barrels and was down to four barrels on September 1st.

On the Tomlinson tract, just east of the Horton, east half of the southwest quarter of section 13, two bores were sunk in 1906 the record of No. 1 showing:

	Feet.
Drive pipe	291
Casing	570
Top of Trenton	1021
Total depth	1045
Initial output, barrels	60

On September 1st this well was yielding about six barrels per day.

The second bore, finished in September, yielded 30 barrels of oil and a large flow of gas.



A bore on the S. Cox farm, northeast quarter of the northwest quarter of section 24, had a fair showing but was spoiled in shooting. One on the J. Keys lease, northeast of 23, started in June at 25 barrels and has since been abandoned. Dry holes were also drilled on the Inman tract, north half of the northwest quarter of 24, and on the Lindley farm, southwest quarter of the southeast quarter of section 13.

The oil from the producing wells above mentioned is piped to a loading rack at Horton. Altogether eight bores were finished east of Horton during the year, of which six came in as producers, while two were dry.

On the east half of section 20 of Washington township, two bores were sunk on the E. D. Barker tract in March and July, 1906, one of which came in as a gas well, the gas being piped to Westfield. The other started at 15 barrels. A record of these bores showed:

	No. 1.	*No.* 2.
	Feet.	*Feet.*
Drive pipe	160	161
Casing	515	515
Top of Trenton	1005	1000
Total depth	1032	1019

In the northwest quarter of section 20 a bore on the Sturdevant lease, sunk to a depth of 1,023 feet, developed a gas pressure of 160 pounds. When first shot it spurted a little oil, but in September was said to be yielding 24 barrels a week when pumped four days, and showed 100 pounds gas pressure. In it the top of Trenton was found at 1,003 feet.

Jackson Township.—This township occupies the center of the north half of the county. In sections 5, 6, 31, 33 and 36 a number of wells drilled for gas have recently developed into oil wells, yielding from one to three barrels per day. The following table shows the field data and location of these wells:

Lease.	Date of Completion.	Drive Pipe, Feet.	Casing, Feet.	Top of Sand, Feet.	Total Depth, Feet.	Location.
A. Graham, No. 1.....	1904	203	525	1,003	1,063	S. ½ N E. ¼ Sec. 6, 19 N., 4 E.
A. Graham, No. 2.....	1904	226	530	1,000	1,049	
A. Graham, No. 3.....	1905	197	535	1,008	1,065	
J. Foulke, No. 1.....	1905	240	545	1,010	1,064	N. W. ¼ Sec. 5, 19 N., 4 E.
Geo. Foulke, No. 1.....	1904	169	520	981	988	N. W. ¼ Sec. 5, 19 N., 4 E.
Geo. Foulke, No. 2.....	1904	162	520	1,003	1,020	
Geo. Anthony, No. 1....	1904	150	510	980	994	S. W. ¼ Sec. 31, 20 N., 4 E.
Geo. Anthony, No. 2....	1904	265	535	1,005	1,057	
M. Blanton, No. 1.....	1904	406	550	1,013	1,032	N. ½ S. W. ¼ Sec. 3, 20 N., 4 E.
A. Geiger.....	1903	308	525	1,008	1,115	S. ½ S. W. ¼ Sec. 33, 20 N., 4 E.
J. Hiatt, No. 1.....	1905	275	535	1,010	1,064	E. ½ S. E. ¼ Sec. 6, 20 N., 4 E.
J. Hiatt, No. 2.....	1905	203	560	1,019	1,078	
J. Jacobs, No. 1.....	1901	70	.....	916	927	N. W. ¼ Sec. 36, 20 N., 4 E.

In Marion County.

The greater part of the productive area near Broad Ripple, Marion County, was abandoned in May, 1906. This pool was opened up in 1896 and 1897, and at one time about 60 producing wells were being operated. The majority of these paid out and yielded the operators a good profit on their investment. The top of Trenton in this vicinity occurs at about 935 feet, or about 120 feet below tide, and the one pay streak lies very near the top.

On December 15, 1906, there were but seven producing wells left in the pool. These were being operated by H. M. Gilchrist and are located on the Wiggins and Lee tracts in the southeast of section 2 and the northeast of section 11 (16 N., 3 E.), about a mile and a half southwest of Broad Ripple. The seven wells were producing about 180 barrels a month, or six barrels per day. The one on the Lee tract, northeast of 11, was making as much as all six on the Wiggins lease, although one of the latter, located across White River, just north of the Lee well, was one of the best in the field, starting at more than 100 barrels. The majority of the wells abandoned in May were still pumping at a profit, but the territory which they occupied had been platted into city lots and the presence of the wells hampered the sales.

There is doubtless quite a quantity of oil yet stored in the Trenton in the immediate vicinity of the old Broad Ripple pool, the limits of which were never clearly defined. The proximity to Indianapolis and the fact that no big wells, or "gushers" were struck prevented the rapid growth and greater extension of the pool at the time it was most productive.

The Production of Petroleum in the Trenton Rock Fields of Indiana.

The raising of petroleum from the porous stratum or reservoir in the depths of the rocks, where it has lain for thousands of years, to storage tanks upon the surface of the earth, where it can be utilized by man, is termed the production.

The evolution of the processes involved in the present advanced methods of production from the primitive one used by the first oil producers in the United States has been a wonderful one and would prove a story of surpassing interest to the practical operator of to-day.

The different steps necessary to the successful development of a good oil property are many, and the tyro who enters the field against operators who have spent a lifetime in mastering the details of producing oil at a minimum cost often finds himself handicapped before he has completed his first well.

Choosing a Locality for Operating.—The first step necessary in the production of oil is the choosing of the locality in which the operations will be carried on. In this step it will be found that the old operator, who has watched the growth of a field from the beginning, is usually wise enough to locate his future wells within the limits of known productive territory, provided he can procure the necessary leases. The beginner more often betakes himself to "promising" territory just outside the limits and puts down a "wildcat" bore. Any one who makes a special study of the oil business will soon note that the Standard Oil Company and other large operators do little "wildcatting," but profit by the experience of the small operators who do it. "Wildcatting" must, however, be done by somebody, as there is no known method of fixing the limits of a field except by test bores put down by speculative individuals.

Necessity of Good Roads in Oil Territory.—Good roads are necessary to the opening up and thorough development of any productive oil territory, and the sooner the farmer finds this out, the greater will be the income which he will derive from this royalty. The iron pipe, tubing and derrick timbers are all of heavy weight, and if the lease is some distance from a railway and the roads leading to it are of mud, as they are apt to be for four or five months if not graveled or macadamized, operations on the lease will necessarily be suspended for that length of time. Many a farm inside of productive territory in Indiana has not been drilled because the operator has noted that the roads leading to it would

compel him to suspend developments from November to April. He cannot afford to be idle five-twelfths of his time, and so operates those leases along pikes over which he can readily haul his necessary supplies. The farmers living in the oil belt who are receiving or might receive large sums in royalty for their oil, should, therefore, see to it that their farms are accessible at all times.

Usual Terms of a Lease.—After deciding on a piece of territory it must either be bought outright or leased from the owner for a term of years. In most cases it is leased, usually for a period of five years or as much longer as production continues. If the adjoining territory is untested, the farmer usually receives from one-eighth to one-sixth royalty on the future production, with a stipulation that drilling is to begin within one or two years, or that a stated rental per acre shall be paid until the first well is drilled. The land owner retains all rights over the surface of the land with the exception of the portion necessarily occupied by the derricks, power houses and storage tanks. On a farm of 80 acres, not more than five need necessarily be kept from cultivation, even though it contain, in time, its full quota of wells. If a good well has been put down on adjoining territory the farmer often receives a bonus of from $10 to $50 an acre, or even more, in addition to the royalty and rental. In many instances the supposed rich strike in time proves of little value. The lease expires without being drilled and the farmer is ahead a sum equal to the bonus advanced.

If on the area leased some good wells are developed, the lease, like the franchise of a street railway, becomes the most valuable part of the so-called "oil property;" and with the wells already in operation is often sold for large amounts. Even though no wells are drilled on a leased farm, the lease often changes ownership a number of times before it expires. The following is a form of lease in common use in Indiana:

This Agreement, made this ..... day of ..... A. D., 190..
Witnesseth, That .....
..... Lessors, in consideration of one dollar in hand duly paid by John Doe, of Lima, Ohio, lessee, do hereby grant, demise, and let unto the lessee all the oil and gas in and under the following described tract of land; also the said tract of land for the purpose of operating thereon for said oil and gas with the right to use water, oil and gas therefrom, except water from wells now on said premises, and all rights convenient for such operations; also the right at any time to remove a part or all of the property, machinery or fixtures placed thereon by lessee. Said land being situated in the.....

of .....County, State of ..... described as follows:
.....
.....
.....
.....

Containing ..... acres more or less. To have and to hold unto the lessee for the term of five years from the date hereof, and as much longer thereafter as oil and gas are found in paying quantities thereon. The lessee shall deliver into tanks or pipe lines to the lessor's credit, the one-eighth part of all the oil produced, and saved from the premises; and shall pay at the rate of one hundred dollars per year for each gas well during the time gas is sold or marketed therefrom.

The lessors may have gas free of cost from any gas well on said premises for use in the dwelling house thereon at their own risk as long as the lessee continues to operate such wells, the lessors making connections for gas at such point or place as may be designated by the lessee.

No wells are to be drilled within two hundred feet of the dwelling house now on the premises without the lessors' consent; whenever the lessors shall request it the lessee shall bury all oil and gas lines which are laid over tillable ground and shall pay all damage to growing crops caused by burying or removing said pipe lines.

It is provided that this lease shall become null and void if a well is not completed on the premises within two years from the date hereof, unavoidable delay excepted, unless the lessees thereafter pay at the rate of 25 cents per acre per year (payable quarterly) until a well is completed, which payments may be made direct to the lessors, or deposited to their credit in the .....
.....
.....

All the provisions hereof shall extend to the heirs, successors, and assigns of the respective parties hereunto, and upon the payment of one dollar, at any time, by the lessee, his successors or assigns, to the lessors, their heirs or assigns; said lessee, his successors or assigns shall have the right to surrender this lease for cancellation; after which all payments and liabilities thereafter to accrue under and by virtue of its terms shall cease and determine, and this lease becomes absolutely null and void.

Witness the following signatures and seals:

Witness:

.... (Seal)
.... (Seal)
.... (Seal)
.... (Seal)
.... (Seal)

State of Indiana,
County of .....
ss:

I, ..., in and for said county in the State aforesaid, do hereby certify that.....
.....
.....

personally known to me to be the same person.. whose name..... subscribed to the foregoing instrument, appeared before me this day in person and acknowledged that ..... signed, sealed and delivered the said instrument as ..... free and voluntary act, for the uses and purposes therein set forth.

Given under my hand .....seal, this ..... day of ..... A. D., 190..

.....

.....

Locating the Wells.—After securing a lease, the operator must choose the site for his first well. It is usually the custom to drill at some point about 200 feet from the property line in order to first obtain the oil which might otherwise be raised by operators of adjoining leases. Various circumstances, such as the dip of the oil bearing rock, variations in the surface level of the tract leased, the location of a permanent power house, etc., are to be considered in determining the site of the well. If wells are down on adjoining leases, the production of the first well, as compared with that of the older ones, can be used to gauge the location of future bores. If a well holds up to ten or 15 barrels a day for three months or more the chances are that it is close to or connected with a large area of porous rock, and that better wells may be located somewhere in the immediate vicinity. The wells are usually put down 400 to 600 feet apart; that distance, in the language of the oil field, being termed a "location."

An unwritten law exists among operators that the lessee of a tract of land shall immediately put down wells when producing wells are drilled on adjoining territories. This is done to offset and protect property lines and prevent the oil underlying one tract from being drained off through another.

As to the amount of acreage to be assigned to an oil well, opinion varies greatly. On the larger leases, ten acres are often given to the well. On the smaller leases, one to every five acres is often drilled. The degree of the porosity of the rock should to a large extent govern the acreage allowed each well. Where comparatively open, the well drains a larger territory and fewer bores are necessary to secure the oil than where the pores are small. One common and very good method of locating the wells on an 80-acre lease is to have them 200 feet back from the outside line and 460 feet apart. This leaves a distance of 920 feet clear in the center, on which the power house can be erected. By this method 14 wells can be placed on each 80 acre tract, and have the center to draw on.

Contracting for the Drilling.—Having selected a site for his first well, the operator next contracts for the drilling. In all parts of Indiana aside from the main field, a written contract should always be made with the driller to sink the bore a certain number of feet, with the privilege of stopping before the distance designated, if so desired, or of going beyond it at a certain stipulated price per foot. The contract should never be worded "to drill to Trenton rock" or "100 feet into Trenton," as a dispute is very likely to arise as to that formation. Inside the main field the different formations are well known, and the experienced driller knows within a few feet the distance at which the Trenton will be found. Outside that field he is apt to be confused, especially if he has to pass through formations not represented in the main field, which he will have to do if the drilling is being done any distance to the south or west.

If it is not possible for the parties who desire the drilling done to determine approximately the distance to Trenton limestone, information regarding that point can be obtained in this office. The distance to be drilled should always include 300 feet into the Trenton, as either gas or oil is likely to be found up to that depth. Bores in untested territory which are to be sunk 1,500 or more feet in depth should begin with holes at least 12 inches in diameter, so as to allow the insertion of several sizes of casing if necessity requires. Oftentimes in such bores a stream of water is struck unexpectedly, or a cave of shale or other soft rock occurs, making a new casing necessary. If the hole has been started too small, it often happens that no additional casing can be inserted. It then has to be abandoned, or else reamed out, the latter being a tedious and expensive process. By beginning with a large opening there is often much saving of both time and expense.

In the main Indiana field in 1906 the average price for drilling was 50 cents per foot, with 25 cents per foot extra for all drive pipe over 100 feet. At this price the operator furnished fuel and water and paid the contractor for cleaning out the well after the latter was shot. The operator furnished the rig and all drive pipe, casing and other supplies.

The Rig or Derrick.—In the Indiana fields but few drilling machines are used, most of the work being done with a standard rig which the operator must first contract for and have erected before the drilling begins. This rig consists of four strong uprights held in position by ties and braces and resting on strong wooden sills, which are preferred as a foundation to masonry. The derrick is

used as a support for the sheave called the crown pulley, which must rest at a sufficient height to swing the heavy drilling tools free from the ground. The average height of the derrick is 72 feet, and it forms the most conspicuous object which characterizes an oil field.

With the derrick are included under the term "rig" all the woodwork and its necessary iron fittings so put together that when boiler and engine are in place drilling can at once begin. The bull wheel and shaft on which the cable supporting the drilling tools is wound; the walking beam to give the vertical motion to the tools, and the band wheels for transmitting power from the engines to the movable parts are, next to the derrick, the most important parts of the rig.

The construction of the rig is usually undertaken by a contractor known as a "rig-builder," for a certain specified sum. In the Indiana field in 1906 the price paid for a new rig complete ranged from $425 to $550. After the well is completed the rig is, in most cases, left standing, though many operators take it down and use it for another well. A considerable saving of outlay for lumber and rig irons is thus effected, but if the well stops flowing or needs cleaning out, a new rig, usually smaller and less expensive, must be built, or else a pulling machine be purchased.

The larger operators own their own "strings of tools" and employ rig builders, drillers, etc., by the month instead of contracting for each well. The head driller or contractor owns his own string of tools and portable engine. His tools cost anywhere from $1,000 to $2,500, according to number and quality. His engine is of a pattern built especially for the purpose and costs about $600. Sometimes the contractor owns several, perhaps a dozen, strings of tools, and is drilling a number of wells at the same time.

Drilling the Well.—The drilling crew consists of four men, two drillers and two tool dressers, who work in pairs, twelve hours each. It is the duty of the driller to stay close to the mouth of the bore and attend to the drilling proper, turning the cable and the temper screw when necessary and controlling the machinery by cords and lever when changing the tools or sand pumping. The tool dresser is the helper to each driller. He fires the boiler, attends to the engine and machinery and dresses or sharpens the bits as each in turn becomes worn.

The wages paid the drillers in the Indiana field in 1906 were $4.50, and the tool dressers $3.50 each per day. The contractor

is responsible for accidents and failure to complete a well. The time necessary to put down a bore 50 feet into Trenton varies much, but is usually from nine to 12 days.

Shooting the Well.—As soon as the porous stratum is passed through, if there is a fair showing of oil, the well is torpedoed

"Ef ther' ez any Standard oil on my farm I perpose t' control th' outpurt."
—Kin Hubbard in Indianapolis News.

or "shot" in order to open up fissures in the porous rock and form a cavity therein into which the oil may flow. In the Indiana field it is now the custom to drill into the Trenton to the bottom of the second pay, if that be present, and then, if possible, gauge the shooting so that the rock will be shattered from the bottom of the drill hole to the top of, but not above, the porous stratum. This prevents the explosion affecting the Utica shale overlying the Tren-

ton and so filling up the cavity with loose debris and rendering the well worthless. Nitro-glycerine is the explosive used, and the amount depends largely upon the texture of the porous rock or so-called "sand." If it is hard and close pored, more explosive is necessary than where coarse and friable. In the latter case a large shot shatters too great a quantity and causes too much trouble in cleaning out after the shooting. An average shot in the Indiana field is now 140 quarts, though some operators persist in drilling deep and using 200 quarts in all wells.

The shooting is done by a contractor who follows it as a vocation. He is usually an agent of the company who manufactures the explosive, and often works on the percentage system, receiving from the company a stipulated sum per quart for the explosive sold.

The nitro-glycerine is hauled overland from the factory in square tin cans holding eight to ten quarts each, and stored in quantity in buildings erected in some out-of-the-way place at various points in the oil field. When a well is ready to be shot, the agent who does the shooting transports, in a light buckboard buggy, padded and fitted for the purpose, a number of these cans to the well. There the glycerine is poured into cylindrical tin cans, called "shells," about five inches in diameter and long enough to hold 20 quarts of the explosive. The average shell is five feet five inches in length. Each shell is conical at the lower end and slightly concave at the upper. As soon as the first shell is filled it is lowered into the bore. When it reaches the bottom the lowering line, by a special device, becomes detached and is drawn up. The second shell is then filled, and when lowered its conical end fits into the cavity at the top of the first. In this manner each of the shells, after being lowered, rests in close connection with the one preceding. The last, or top shell, is fitted in a special manner with a waterproof percussion cap so arranged beneath a flat iron plate that when the latter is struck the cap is exploded and in turn sets off the nitro-glycerine. After the lowering line of the last shell has been reeled up, an iron casting, called a "go-devil," is dropped into the bore, and the "shooter" and spectators retreat some distance from the derrick.

In some places the percussion cap is so arranged that it can be readily set off with an electric spark, communicated to it by a wire which is connected with a hand battery. This device is more commonly used where the casing is removed section by section after the explosive has been placed in the bore and then reset as soon as

the shooting is over. Such removal takes but an hour or two and all danger of collapse or breaking the casing is thereby obviated.

When the ntiro-glycerine is exploded, a person 100 yards away will, aften an interval of 30 to 50 seconds, experience a slight

"By ginger, that glicereen makes a feller rise in his perfession."
—Kin Hubbard in Indianapolis News.

jarring of the earth, accompanied by a muffled report somewhat louder than a pistol shot. A minute or so thereafter a roaring sound is heard and a solid column of oil and water is seen issuing from the mouth of the bore. This rises higher and higher until it often reaches far above the derrick and there breaks into spray. Blown up with it are many fragments of stone and the remains of the tin cannisters and "go-devil," shattered into a thousand par-

ticles. Pieces of porous rock blown up from a depth of a thousand feet often weigh six to eight pounds.

The flow of oil resulting from the explosion usually soon subsides and, as soon as possible, tubing two to two and a half inches in diameter and reaching to the bottom of the bore, is put in and connected with a tank which has been erected near by. These tanks are cylindrical, are constructed of wooden staves, and are usually gauged to hold 250 barrels each. In such a tank each inch in depth equals two and a half barrels of oil; therefore, in oil field vernacular, a yield of "ten inches a day" means 25 barrels. The cost of such a tank in the Indiana field in 1906 was $90.00.

Pumping the Oil.—After tubing the well and connecting it with the tank, the necessary pumping apparatus must be attached. If a number of wells are to be drilled a power house is located near the center of the lease and a small gas or steam engine placed therein. Each well is supplied with a jack and balance weight, to which the necessary pumping or sucker rods which ply up and down inside the tubing are attached. When a number of wells are pumped by one engine the power is transmitted to the pumping jack of each by means of steel pull rods or wire ropes provided with suitable angle knees to change the direction of the pull. Where the surface is level the rods run about two feet above the ground and rest in notches cut in the tops of short posts or props. Where the surface is broken or uneven the rods are suspended above ground by ropes attached to poles or posts which are set in a row between the power house and well.

The engine in the power house runs an oscillating pull-wheel which gives horizontal movement to the rods radiating from it to the different wells. The pull-wheel draws the rods in one direction, and on the return the weight of the sucker rod, hanging from the jack, draws them back. In this way wells have been pumped one mile from the power house, and often as many as twenty wells, and sometimes as many as forty, are pumped by a single engine. More than twenty-five or thirty are, however, too many, for if the power should happen to break down all the wells are stopped. Again, a pumper (the man in charge of the engines and wells) cannot look after more than that number and do it right. The fuel used for pumping is usually gas, the wells on the lease often furnishing enough; though in many instances it is piped from a distance. The material pumped is run first into a barrel tank to settle out the water, and from this the oil passes off into storage tanks.

After a tank has been filled with oil, the latter must often be steamed to reduce the impurities of sediment to a minimum. This is done by connecting pipes from the engine with the bottom of the tank and forcing steam through the oil. From three to four hours is usually necessary to steam a 250-barrel tank. The process of "production" is then complete and the oil is ready for the market.

Marketing the Oil.—When a tank is full or nearly so the pumper notifies a gauger of the purchasing company (Indiana Pipe Line Company, a branch of the Standard Oil Company), who comes and measures its contents. It is then turned into the lines of the company (the Standard) and the pumper notifies the Indiana branch of that company at Montpelier. There, after deducting two per cent. for sediment, leakage, etc., certificates are mailed to both the producer and the party owning the land, stating the number of barrels to their credit in the lines of the purchasing company, together with the market price of the same. These certificates can be cashed at the various banks throughout the oil field, or are payable over the counters of the company at Montpelier.

Cost of a Producing Well in the Main Indiana Oil Field in 1906.—On account of the increase in the price of lumber and iron tubing and piping, the cost of a producing well in the Trenton rock field of Indiana has considerably increased in recent years. A careful estimate of the average cost of drilling and fitting up the first productive well on a lease was made by a leading operator in each of the Jay and Huntington county portions of the field in October, 1906. These estimates resulted as follows:

	Jay.	*Huntington.*
Rig or derrick	$425	$550
Drilling	575	580
Drive pipe	140	180
Casing	95	170
Shooting	100	140
Cleaning	30	40
Tubing and pumping outfit	210	225
Power house and power	1,000	1,500
Two 250-barrel tanks	180	200
One 100-barrel tank	35	35
Belting, lead lines and surface rods	170	210
Incidentals	100	100
Totals	$3,060	$3,930

In the above estimate, the price of drilling is put at 50 cents a foot plus the cost of fuel, which is extra and averages about

$50 per well; that of 8-inch drive pipe at 95 cents in the Jay County field and $1.00 in the Huntington; 6¼-inch casing at 36 cents in Jay and 37 cents in Huntington; tubing at 16 cents; sucker rods at 3¾ cents; jack and pumping outfit at $50 and shooting at 70 cents a quart; these being the ruling prices in the two fields. The incidentals include the cost of necessary teaming and the expenses (livery hire, board, etc.) of the operator or field manager while overseeing the work.

The second well on the lease will cost $1,600 to $2,000 less as the rig, tanks, power house and power can be used for both wells, though there will be a loss of $125 in tearing down and rebuilding the derrick. It is not customary to build a power house until three or four producing wells have been finished on the lease, but if not built, an engine and boiler for pumping must be purchased for each producing well, which will cost $325 to $450. With the advanced methods of pumping by which oscillating pull-wheels, rods, etc., are used, 20 or more wells can be connected to one power, and the cost of production be thereby greatly decreased.

No two wells in the field cost the same. One reason for this is that the length of drive pipe necessary is so variable, ranging from 25 to 450 feet. The number of feet of casing necessary also varies greatly in different parts of the field. Some operators use but one or two derricks on a lease, putting in their stead, as fast as removed from a newly drilled productive well, a set of "derrick poles." costing from $10 to $15. Others leave the derrick over each well. These are often blown down or burned, thus causing a loss of $300 to $400. The cost of the lead lines and surface rods on a lease will increase proportionally to the number of producing wells. In 1906 the price of a two-inch lead line pipe was 11 cents, while that of surface rods was 4¼ cents per foot.

If the rig is moved and used for successive wells a pulling machine to clean the pump and valves will be necessary on the lease and will cost about $225. Where the oil requires steaming an extra boiler and boiler house, both costing close to $500, will be necessary. Some companies also put up a dwelling costing on an average $500 for each of their pumpers.

One operator stated that the average cost per well of 16 to 20 wells on a 160 acre lease in Huntington County was $2,000. A second operator stated that he expended an average of $2,200 each for 16 wells in the same county. Another said that in Wells County he could, after the power was located, hitch a well onto it for $1,200. In the deep pay in Delaware County, the average cost is

probably near $3,000. The actual cost of 39 wells in the Trenton rock fields of Indiana and Ohio was $1,724.85 each. This last is perhaps as fair an estimate as can be given.

Cost of Operating a Lease.—The cost of operating an oil lease after the production has been established need not be more than $100 per month, the salary of the pumper being $60, and the cost of fuel about $40. A dozen, or even 20 wells can, however, be operated almost as cheaply as one after they have been connected with the power. An extra pumper may have to be employed, but otherwise no additional expense is entailed. Where the plant has been established it will pay to operate a lease of eight or more wells, even if the yield is only one barrel each per day, provided the price of oil is as high as it was throughout the year 1906.

The estimate of expense and income from eight one-barrel wells, after deducting the royalty of one-sixth, is as follows:

Income per month—		
200 barrels of oil at $0.85 (average price in 1906)		$170 00
Salary of pumper	$60 00	
Cost of fuel	40 00	
		100 00
Net income per month		$70 00

With twelve one-barrel wells on the lease the income would be $255 and the expense $100, a net gain of $155 per month.

The running expenses of 21 wells in Huntington and Grant counties were said by one operator to be $144.42 each per annum. Another stated that in Huntington County ten wells on an 80-acre lease will cost $1,000 a year, while 20 on a 160-acre tract would not cost over $1,200 per year.

The actual average cost of producing oil in Indiana at present is variously estimated at from 30 to 50 cents per barrel, though one operator claimed that on a very productive lease in Delaware County he was producing it for 12½ cents. This includes the interest on the investment. Out of the profit above cost of production, the principal invested in leases and wells, and also the taxes, must be paid. In the early history of the field when the average output was much greater, the cost of production was not over 20 to 30 cents per barrel, and whatever was received above that was clear gain.

From what has been written it will be seen that, with the possible exception of the field at Casey, Illinois, the cost of drilling and operating a lease in the main Indiana Trenton rock field is as

low or lower than elsewhere in the eastern United States, for the following reasons: (a) The wells are comparatively shallow, the Trenton limestone in most instances being struck at less than 1,000 feet. (b) It is seldom that more than 150 feet of drive pipe and 400 feet of casing are necessary. (c) On account of a comparatively level surface a large number of wells can be connected to and pumped with one power. (d) Gas for fuel or for running gas engines is as yet available in many parts of the field and if not present, coal is as cheap as in any other locality. (e) Transportation facilities are excellent, a system of pipe lines permeating all parts of the main field.

Whatever the price of oil, the profits will depend largely upon the way the property is managed. Success as an oil operator depends upon the same watchful energy as brings success in any other business. One's pumps should be kept steadily at work so as to get all the oil possible. The drilling tools, lead pipes and pumping machinery, should be kept in good repair; especially in late autumn should they be thoroughly overhauled and put in prime condition for the winter months. If the lead lines are left above ground or are but shallowly buried, they often freeze and burst. A poorly managed lease is liable to be tied up for a month or more on this account; while a neighboring lease which has everything in good shape for the winter produces nearly its normal output of oil.

Above all one should be on the lookout for overflow and leakage. Much of what would otherwise be profit in oil property is allowed to go to waste. Finally, if the property is inside the limits of productive territory, the successful oil man is he who lets other people do the wildcatting and who follows where they lead.

STATISTICS OF THE INDIANA TRENTON ROCK PETROLEUM INDUSTRY FOR 1906.

For the second time in recent years the output of Trenton rock petroleum fell off in 1906, the loss for the year being 3,129,613 barrels, or 28.8 per cent. This loss was not due to decrease in price, as the average price was higher than in 1905, but was primarily due to a large decrease in the number of new bores, brought about by the migration of the leading operators to the Illinois and other more productive fields.

The fluctuations in price during the year were very slight; there being but eight cents difference between the minimum and maximum

prices paid. Starting the year at 89 cents per barrel, it held this figure until April 13, when it rose to 91 cents and again on April 25 to 93 cents, the maximum. This price was paid until July 25, when it dropped to 91 cents. On August 1st there was a decline of 2 cents, and again on August 15 and 25, when the minimum price of 85 cents was reached. This price it held to the end of the year. The average price for the year, taking both days of time and amount received into consideration, was 88 3-5 cents, as against 84 4-5 cents in 1905 and $1.07½ in 1904.

The total production of Trenton rock oil in Indiana in 1906 was 7,762,825 barrels which, at the average price of 88 3-5 cents had a value of $6,877,863. Compared with 1905, this shows a loss of 3,129,613 barrels, or 28.8 per cent., as against a loss in 1905 over 1904 of 3.4 per cent. On account of the higher average price, the amount received by the producers was $2,358,925, or 25.5 per cent. less than in 1905.

The first of the following tables gives a complete record of the monthly production of petroleum from the Trenton limestone fields of Indiana for the 16 years beginning January 1, 1891, and ending December 31, 1906. This does not include the amount used in the field for fuel and other purposes, or that wasted by the burning of tanks or the leaking of pipes, but only that shipped or piped by the companies who purchase the oil from the operators. The second table shows the annual production, the average yearly price and the total value by years for the same period:

I. TOTAL PRODUCTION OF TRENTON LIMESTONE PETROLEUM IN INDIANA FROM 1891 TO 1907, BY MONTHS.

(Barrels.)

MONTH.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.
January.....	6,171	15,841	111,824	259,000	300,568	365,582	290,746	317,014
February.....	5,981	18,946	96,025	232,107	230,559	241,743	309,922	272,780
March.....	5,159	24,794	134,549	282,376	310,303	386,586	341,961	325,301
April.....	4,973	26,184	146,493	287,330	352,077	395,032	328,779	310,034
May.....	5,757	31,033	186,939	321,502	397,001	417,963	340,023	311,208
June.....	8,136	40,888	209,616	333,479	403,569	434,167	369,803	320,477
July.....	10,809	49,203	241,666	327,349	434,376	422,968	375,249	314,861
August.....	11,603	56,109	248,353	345,031	420,132	407,238	371,921	332,777
September.....	16,500	66,034	245,615	319,588	409,169	415,675	362,528	326,264
October.....	19,029	95,699	252,568	339,424	393,153	394,283	408,179	319,490
November.....	20,801	129,270	245,607	304,030	373,789	337,331	430,958	300,644
December.....	21,715	144,067	236,038	337,450	361,436	362,164	423,069	300,457
Totals.....	136,634	698,068	2,335,293	3,688,666	4,386,132	4,680,732	4,353,128	3,751,307

MONTH.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.
January	297,291	353,451	425,140	554,038	651,355	714,594	1,038,324	759,518
February	220,440	302,493	384,735	460,073	568,789	664,058	804,100	657,201
March	290,257	364,590	432,922	573,412	724,969	797,133	1,037,320	678,788
April	325,774	381,804	447,261	579,711	680,921	804,121	964,242	684,810
May	344,831	426,363	482,118	635,752	751,348	851,071	1,011,859	701,766
June	334,282	446,492	481,807	633,452	809,438	940,391	1,011,965	692,390
July	329,086	437,087	506,065	696,911	831,005	998,229	937,960	684,056
August	347,621	466,127	523,106	697,040	838,615	1,084,560	916,803	673,721
September	332,283	418,716	519,087	672,611	857,117	1,104,771	840,804	563,100
October	326,781	467,521	532,960	725,973	873,160	1,139,000	791,881	607,178
November	326,802	406,684	510,788	656,457	778,323	1,098,832	765,078	547,134
December	332,266	441,347	479,485	650,131	796,291	1,084,270	772,102	513,163
Totals	3,807,714	4,912,675	5,725,474	7,535,561	9,161,331	11,281,030	10,892,438	7,762,825

II. PRODUCTION OF TRENTON ROCK PETROLEUM IN INDIANA FROM 1891 TO 1907, WITH VALUE.

	1891.	1892.	1894.	1894.	1895.	1896.	1897.	1898.
Total production (barrels of 42 gal.)	136,634	698,068	2,335,292	3,688,666	4,386,132	4,680,732	4,353,138	3,751,307
Total value at wells of all oils produced, excluding pipeage	$54,787	$260,620	$1,050,882	$1,774,260	$2,807,124	$2,954,411	$1,871,849	$2,228,276
Value per bbl.	$0 40	$0 37	$0 45	$0 48	$0 64	$0 63	$0 43	$0 59⅔

	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.
Total production (barrels of 42 gal.)	3,807,714	4,912,675	5,725,474	7,535,561	9,161,331	11,281,030	10,892,438	7,762,825
Total value at wells of all oils produced, excluding pipeage	$3,331,750	$4,740,731	$4,775,045	$6,450,440	$10,457,659	$12,127,107	$9,236,788	$6,877,863
Value per bbl.	$0 87½	$0 96½	$0 83⅔	$0 85⅔	$1 14 3/20	$1 07½	$0 84⅘	$0.88⅔

From the first of the above tables it will be seen that the largest production of the Trenton rock petroleum in Indiana in any one month to date was in October, 1904, when 1,139,000 barrels were brought to the surface. The total production of Indiana Trenton rock oil for the 16 years reached the enormous sum of 85,109,048 barrels, which sold for $70,999,592, or an average of $4,437,474 per year.

In the third table there is shown the number of wells completed in the Indiana Trenton limestone fields by months from June, 1891, to January, 1907:

III. NUMBER OF WELLS COMPLETED IN THE INDIANA TRENTON LIMESTONE OIL FIELDS FROM 1891 TO 1907 BY MONTHS.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
1891	.....	.....	.....	.....	.....	.....	6	6	15	15	15	8	65
1892	11	13	18	13	17	19	17	30	25	52	33	47	295
1893	20	30	31	36	45	47	47	55	27	72	56	76	542
1894	90	103	103	80	110	107	84	123	100	107	97	85	1,189
1895	61	45	81	111	122	153	132	140	129	106	102	85	1,267
1896	76	90	86	136	148	150	113	121	70	58	66	66	1,180
1897	41	35	40	47	49	52	60	45	55	89	119	54	686
1898	41	23	29	43	38	55	53	80	72	82	92	86	694
1899	75	48	68	64	87	99	77	104	106	118	106	105	1,057
1900	113	67	98	148	165	163	158	155	135	152	118	108	1,580
1901	111	72	81	121	167	171	167	169	184	207	220	132	1,802
1902	176	113	169	182	247	297	288	279	323	295	320	243	2,932
1903	168	178	233	236	331	408	377	387	337	366	375	290	3,686
1904	235	157	234	202	296	393	394	383	378	388	320	344	3,724
1905	194	130	149	185	196	157	159	145	130	108	163	166	1,882
1906	135	90	84	68	106	142	120	100	93	69	66	59	1,132
Total	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23,713

From this table we learn by subtraction that 750 fewer bores were sunk for oil in the Trenton rock fields of Indiana in 1906 than in 1905. This was a loss of 39.8 per cent., as against a loss in 1905 of 49.5 per cent. over the year previous.

From the table it may also be learned that, up to January 1, 1907, 23,713 bores had been drilled in the Trenton rock fields of Indiana for oil alone. On that date there were 16,221 producing wells in the Trenton rock fields as against 16,266 on January 1, 1906, a loss of 45 for the year.

By subtraction it will be noted that of the total number of bores sunk for oil in the Trenton rock fields of the State, 7,492 have proven dry, or have been abandoned as non-productive. The number abandoned in 1906 was 1,053, or 446 more than in 1905, while the number of dry holes drilled during the year was 124, or 113 less than in 1905. Of the total number of bores sunk in 1906, 10.9 per cent. were dry, as against 12.6 per cent. of those drilled in 1905, and 10.2 per cent. of those sunk in 1904.

For the first time in the history of the field, the number of dry holes and abandoned wells exceeded the number of bores sunk, the excess of the former being 45, while the number of former producing wells abandoned was 45 greater than the number of productive wells completed. During the months of August, October, November and December, the number of wells abandoned exceeded the number drilled by 239.

On October 15, 1906, there were approximately 16,397 producing

wells in the Trenton rock fields of the State. The production of oil for the entire month of October was 607,178 barrels, or an average of 1.19 barrels per well for each day of the month. The average daily output in October, 1905, was 1.59 barrels for each productive well. This loss was due mainly to the greatly decreased number of new bores sunk during the year, and to the large number of old producing wells abandoned.

The following table shows the number of producing wells, number of dry holes, total bores, average initial production of wells drilled, and number of wells abandoned in each of the Trenton rock oil producing counties of Indiana in 1905 and 1906.:

Counties.	Producing Wells, 1905.	Producing Wells, 1906.	Dry Holes, 1905.	Dry Holes, 1906.	Total Bores, 1905.	Total Bores, 1906.	Percentage of Dry Holes, 1905.	Percentage of Dry Holes, 1906	Av. Initial Output of Productive Wells, Bbls., 1905.	Av. Initial Output of Productive Wells, Bbls., 1906.	Abandoned Wells, 1905.	Abandoned Wells, 1906.
Adams	83	44	11	4	94	48	11.7	8.3	9.5	10	104	120
Blackford	55	55	10	9	65	64	15.4	14	7.3	12.6	95	152
Delaware	570	141	83	39	653	180	12.7	21.7	32.6	33.2	16	208
Grant	369	216	34	20	403	236	8.4	8.5	10.7	8.1	139	307
Hamilton	3	6	0	3	3	9	0	33.3	15	26.6	0	2
Huntington	159	121	2	2	161	123	1.2	1.6	19.3	13.6	35	6
Jay	171	178	33	27	204	205	16.1	13.1	15.8	15.4	41	65
Madison	30	2	25	1	55	3	45.4	33.3	15.7	15	13	32
Miami	4	1	1	0	5	1	20	0	8.7	10	2	16
Randolph	46	18	34	8	80	26	42.5	30.7	36.8	33.7	0	5
Wabash	1	2	0	0	1	2	0	0	6	10	11	0
Wells	154	224	4	11	158	235	2.5	4.6	11.4	9.4	151	125
Totals	1,645	1,008	237	124	1,882	1,132	*12.6	*10.9	*20.6	*14.6	607	†1,053

*Denotes average.

†Includes 15 abandoned in Marion County

From the table it will be seen that in most of the counties the number of productive wells drilled fell off very greatly. However, in Wells County there was a gain of 70, or 45 per cent., in the number of such wells, the county again taking the lead in new work, after having been in second or third place for several years. Jay County also gained seven over the previous year, while Blackford just held her own.

The average initial output of the new wells fell off six barrels per well, which was the largest loss in recent years. The initial output of the productive deep pay wells in Delaware and Randolph counties changed but little, there being a gain of one-half barrel in the former and a loss of 3.1 barrels in the latter. The percentage of dry holes in these two counties was, however, much above the average.

Huntington still maintains its good record among the older producing counties, there being but two dry holes among the 121 bores sunk within its bounds. This was a percentage of but 1.6 against the average of 10.9 for the field. The average initial output of the wells in Huntington fell, however, from 19.3 to 13.6 barrels.

Jay County made an excellent record, the average initial output of her wells falling off but .4 of a barrel, while her percentage of dry holes was reduced from 16.1 to 13.1.

Grant County forged ahead of Delaware in the number of new productive wells, and was ahead of Wells County in the number of bores sunk, but her percentage of dry holes was nearly double that of Wells, the latter ranking, as she has for several years, next to Huntington in low percentage of barren bores. From a careful study of the table one can learn many other facts of interest regarding the relative importance of each county in the field.

Corniferous Rock Petroleum.

The Corniferous formation is the lowest or oldest division of the Devonian system in Indiana, being represented in the State by sandstones with a maximum thickness of 20 feet, which are thought to correlate with the Schoharie group of New York, or by limestones 5 to 65 feet in thickness. The waters in which the materials of the Corniferous limestone were deposited were clear and comparatively pure, and in them sponges, corals, crinoids, trilobites and lower animal forms existed in great profusion. From the lime secreted by these marine forms the upper and purer beds of the Corniferous rock are mainly composed; and from the slow destructive distillation of the animals themselves a part of the oil contained in the formation was doubtless derived. The rocks of the Corniferous formation comprise the surface rocks of the State over a strip of 5 to 40 miles in width, extending from the Ohio River at Jeffersonville north and northwestward to the vicinity of Logansport and Monticello. The outcrop of the eastern margin of the Corniferous passes through the following counties: Eastern Clark; western Jefferson, eastern Jennings, central Decatur, eastern Rush, northeastern Hancock, central Hamilton, western Tipton, southwestern Howard, eastern Carroll and eastern Cass. West of that margin the Corniferous is found either on the surface or underlying the latter formations in all the counties. North of the Wabash River at Logansport, especially in Jasper and

Laporte counties, the Corniferous has also been found in a number of deep bores sunk for oil, but on account of the thick mantle of overlying drift its exact limits are unknown.

Immediately above the Corniferous and west of its surface exposure, there is always found a thick bed of blackish or brownish shale, known as the Genesee or New Albany shale. This ranges in known thickness up to 195 feet and forms the necessary impervious cover which has retained the oil of the Corniferous in the parent rock. The Genesee shale is formed largely of the spores of low forms of fresh water or brackish marsh plants known as Rhizocarps, which flourished in vast numbers during the time the materials afterwards compressed into the shale were being deposited. The shale is rich in bitumens derived from the destructive distillation of the spores of these ancient Rhizocarps. When kindled it will burn until they are consumed, and it is, therefore, by the uninitiated often mistaken for coal. These bitumens are, by natural processes, sometimes separated from the shale and in the form of gas or petroleum are collected in reservoirs in it or in the underlying Corniferous formation. Much of the oil now being obtained from the Corniferous rocks may thus have entered that formation from the overlying shale.

Petroleum in commercial quantities has been found in the Corniferous rocks of Indiana at Terre Haute, Vigo County, in the vicinity of Birdseye, Dubois County, near Salem, Washington County, and northwest of Medarysville, Jasper County. The territory opened up at each of these points is, however, limited in area, and the output, except at Terre Haute, small in quantity. But one well which yielded petroleum in commercial quantities from the Corniferous limestone was sunk in Indiana in 1906.

Terre Haute Field.

Early History.—Crude oil was first discovered in the Corniferous rocks of Indiana in the city of Terre Haute in 1865. In that year Chauncy Rose started a bore near the present site of the Terre Haute House, in search of water. At 1,629 feet oil was struck in the Corniferous limestone, the yield being almost two barrels per day. This was shut out and the bore continued to a depth of 1,793 feet, where a strong vein of sulphur water was encountered.

In 1869 a second bore was drilled expressly for oil. It was located on the Wabash river bank between Walnut and Poplar streets. In it oil was found in the black shale and a gray limestone

at a depth of 1,642 to 1,667 feet, but the amount was not sufficient to justify pumping.

A detailed section of the second well was published by Prof. E. T. Cox, then State Geologist, in the Second (1870) Report of this Department*. Of it Prof. Cox wrote: "In this well experienced borers were employed and the record of the strata passed through may be relied on as accurate. The record has been carefully made and each layer of rock tested to determine its character, consequently the sandstone and other strata are correctly placed."

Since a number of new bores will probably be sunk in the vicinity of Terre Haute in 1907, the section of the well is reprinted herewith, in order that operators and drillers may have for ready reference a detailed statement of the strata overlying the oil-bearing Corniferous limestones in that region. The section begins about 20 feet above low water in the river.

Section of Bore Sunk on River Bank at Terre Haute in 1869.

		Feet.	*Inches.*	*Feet.*	*Inches.*
1.	Sand and gravel	100	..	100	..
2.	Soapstone	64	6	164	6
3.	Coal	6	2	170	8
4.	Hard sandstone	2	3	172	11
5.	Soapstone	10	..	182	11
6.	Coal	3	..	185	11
7.	Soapstone	4	3	190	2
8.	Gray sandstone	5	10	196	..
9.	Blue soapstone	...	10	196	10
10.	Gray sandstone	...	6	197	4
11.	Blue soapstone	12	9	210	1
12.	Soft black shale	6	..	216	1
13.	Coal	...	9	216	10
14.	Soapstotne	7	7	224	5
15.	White sandstone (conglomerate)	30	3	254	8
16.	Blue shale	7	2	261	10
17.	Coal	2	3	264	1
18.	Black shale	10	..	274	1
19.	White soapstone	3	..	277	1
20.	Black shale	15	..	292	1
21.	White soapstone	8	..	300	1
22.	Black shale	3	3	303	4
23.	Coal	3	..	306	4
24.	Soapstone	17	8	324	..
25.	Sand rock	3	..	327	..
26.	Soapstone	20	..	347	..
27.	Sand rock	10	..	357	..

*This section was reprinted by Dr. J. T. Scovell in the Twenty-first (1896) Report of the Department, now out of stock.

		Feet.	Inches.	Feet.	Inches.
28.	Blue shale	22	..	379	..
29.	Limestone	2	..	381	..
30.	Blue shale	31	..	412	..
31.	Light shale	5	..	417	..
32.	Blue shale	60	..	477	..
33.	Sandstone	7	..	484	..
34.	Blue shale	24	..	508	..
35.	Sandstone	3	..	511	..
36.	White shale	10	..	521	..
37.	Blue shale	147	..	668	..
38.	Hard gritty slate rock	11	7	679	7
39.	Hard gray sandstone	14	5	694	..
40.	Hard limestone	11	..	705	..
41.	White limestone	24	..	729	..
42.	Gray limestone	2	..	731	..
43.	Limestone	14	..	745	..
44.	White limestone	82	..	827	..
45.	Soapstone	3	..	830	..
46.	Brown limestone	35	..	865	..
47.	Soapstone	5	..	870	..
48.	Lime rock	9	..	879	..
49.	Soapstone	6	..	885	..
50.	White limestone	7	..	892	..
51.	Soapstone or gypsum?	2	..	894	..
52.	White limestone	21	..	915	..
53.	Gray limestone	5	..	920	..
54.	Limestone and soapstone	5	..	925	..
55.	Gray limestone	5	..	930	..
56.	White limestone	15	..	945	..
57.	Fine blue limestone	2	..	947	..
58.	Dark gray limestone and flint	73	..	1020	..
59.	Light gray limestone	7	..	1027	..
60.	Blue gray limestone	7	..	1034	..
61.	Soapstone (fire-clay)	26	..	1060	..
62.	Gray limestone	24	..	1084	..
63.	Gray sandstone	3	..	1087	..
64.	Soapstone (fire-clay)	5	..	1092	..
65.	Quartz and shale mixed	166	..	1258	..
66.	Quartz, slate and soapstone	3	..	1261	..
67.	Slate rock	21	..	1282	..
68.	Soapstone	33	..	1315	..
69.	Slate rock	7	..	1322	..
70.	Soapstone	235	..	1557	..
71.	Soapstone and sandstone	10	..	1567	..
72.	Fine sandstone	15	..	1582	..
73.	Blue soapstone	40	..	1622	..
74.	Black shale	15	..	1637	..
75.	Red shale	5	..	1642	..
76.	Black shale	15	..	1657	..
77.	Lime rock	5	..	1662	..

		Feet.	Inches.	Feet.	Inches.
78.	Black shale	5	..	1667	..
79.	Gray lime rock, oil near the top	149	..	1816	..
80.	Gray sand rock	23	..	1839	..
81.	Lime rock	73	4	1912	4

According to Prof. Cox, salt water was found at 254 feet in white sandstone, No. 15 of the above section; strong sulphur water at 947 feet in "fine blue limestone" No. 57; strong salt water at 1,557 feet in the soapstone No. 70; oil at 1,642, 1,657 and 1,667 feet in the shales and gray limestone, Nos. 75 to 78; sulphur water at about 1,800 feet in the gray lime rock No. 79; and sulphur water at 1,840 and 1,912 feet in the lime rock No. 81.

Prof. Cox also stated that a third bore, located a quarter of a mile northeast of the Rose well, was sunk in 1869, and "passed through the black slate at 1,600 feet and 25 feet lower, in limestone which I refer to the Corniferous, a vein of oil was found which yields 25 barrels per day."*

In the later report on Vigo County by Prof. Cox, he stated: "Three wells that reached petroleum bearing strata have been bored at Terre Haute. One of these furnished from two to four barrels of moderately heavy oil in 24 hours. It did not flow out at the top, but had to be pumped. This materially advanced its cost, and owing to the extremely low price pertoleum has commanded in the market for some years, the well was abandoned and closed up."†

In the report for 1870, Prof. Cox also stated that "The Wabash River at Terre Haute runs on an anticlinal axis,"‡ and Dr. T. Sterry Hunt in the same volume states**: "This locality (Terre Haute) on the Wabash River is, according to Prof. Cox, on the line of a gentle anticlinal or uplift, which is traced a long distance to the west of south."

Phoenix and Other Wells.—In May, 1889, oil in large quantities was struck in the Diall or Guarantee No. 1 well located on the alley between 9th and 10th and Chestnut and Eagle streets, near the center of Terre Haute. When the drill first struck the oil bearing stratum on the night of May 6th, the flow was so great that quite a lake of oil accumulated around the derrick, and there was some alarm lest a destructive fire should result. The drill was then pulled out of the well, and as soon as the end left the

*Second Report of the Geological Survey of Indiana, 1870, p. 135.
†Seventh Ann. Report, Geological Survey of Indiana, 1875, p. 111.
‡Page 126.
**Page 136.

mouth of the casing, a solid stream of oil four and a half inches in diameter shot into the air a distance of 40 to 50 feet. While running at this rate, there was probably a little over a barrel a minute pouring from the well, and when the pressure decreased from the first spurt, which lasted only fifteen minutes, the flow steadied down to a four and a half inch stream spurting about three feet above the mouth of the well. A tank with a capacity of 20 barrels was put under the pipe, and it was filled to overflowing in just 22 minutes.

The result of this strike was like that of every other similar one in the history of the petroleum industry. Hundreds of oil operators from far and near flocked to Terre Haute. Real estate almost doubled in price. Twenty-four new companies were formed, 18 of which made locations. Twenty or more bores were put down in 1889 and 1890 to the required depth within three miles' radius of the first gusher, struck the proper stratum, and for the most part found—nothing. Two, within a short distance of the original well, yielded oil in quantity. The yield of one was soon overcome by salt water, as was also that of the original well. The other, the Phoenix well, now owned by the firm of Prox & Brinkman, has continued to yield to the present day, and has proven the most productive oil well ever sunk in the State.

No further prospecting was done until 1899, when two bores were completed. One of these, about two miles north and one-half mile west of the Phoenix, was a salt water well. It was located on the Aaron Conover farm, the site being 30 feet lower than that of the Phoenix well. The following is the driller's record of the strata passed through:

Record of Conover Well No. 1.

		Feet.	*Feet.*
1.	Gravel	102	102
2.	White shale	56	158
3.	Blue shale	3	161
4.	Gray shale	29	190
5.	Coal	6	196
6.	Blue and white shale	96	292
7.	Coal	2	294
8.	Gray slate	31	325
9.	Sandstone	10	335
10.	Light and dark shale	125	460
11.	Brown and white sandstone, bottom close and hard	40	500
12.	Very dark shale and soapstone	45	545

		Feet.	Feet.
13.	White sandstone, top soft	110	655
14.	Very hard white limestone	360	1015
15.	Sandstone, bluish	20	1035
16.	Limestone, white	10	1045
17.	Sandstone, dark bluish	30	1075
18.	Blue shale	150	1225
19.	Black shale	5	1230
20.	Sandstone, white, close	15	1245
21.	Black close shale	50	1290
22.	Sandstone, bastard, gray	15	1310
23.	Black shale, top sandy	30	1340
24.	Light colored sandstone	15	1355
25.	Slate	25	1380
26.	Light gray sandstone	80	1460
27.	Shale	25	1485
28.	Limestone, shells and shale	65	1550
29.	Soapstone	35	1585
30.	Limestone	5	1590
31.	Black shale	90	1680
32.	Corniferous limestone	15	1695

A little sulphur water was struck in the sandstone No. 11, at about 475 feet. The last 70 feet of No. 13, i. e., from 585 to 655 feet, was hard, with a great deal of iron ore scattered through it, and with a plentiful supply of water which rose to the top of the bore. At intervals in the white limestone No. 14, which was doubtless the Mitchell and Bedford oolitic stones, there were three or four small breaks, from two to five feet in thickness. The upper 15 feet of No. 18 was sandy and shelly. A large vein of very salt water was struck at about 1,420 feet in No. 26. This filled the bore and flowed 200 or more barrels daily until it was shut off. Another weaker vein was encountered in No. 28, at a depth of 1,510 feet. After drilling 15 feet in the limestone immediately below the black shale, the bore was abandoned, on account of salt water which overflowed the top.

In the second bore, known as the MeWhinney well, located about 40 rods northeast of the Pheonix, oil was found which partially filled the hole.

For 12 or more years the Phoenix well yielded an average of 1,000 barrels per month. In the last few years this has gradually lessened and in 1906 the average was 450+ barrels per month. The combined output of it and the MeWhinney well for 1906 was 7,269 barrels as against 7,044 in 1905. This was sold to local consumers at an average price of $1.15 per barrel, the whole amount received being $8,456.

The Vi-Clay Well.—In the fall of 1906 a test bore was put down on the Joslin tract of 20 acres in the southeast quarter of the northeast quarter of section 23 (11 N., 8 W.) Riley township, about 12 miles southeast of Terre Haute, and two miles southeast of Riley, a station on the E. & I. Railway. It was completed in November by the Vi-Clay Oil Company, composed of farm owners and citizens of the vicinity. This company had about 4,000 acres under lease, and the Joslin well was their first test-bore. The elevation at the well is said to be ten feet lower than that at the near-by 12-mile post, which is 130 feet higher than that of the Union Station at Terre Haute. This would make the site of the well about 605 feet above tide. The record of the well as furnished by George Scott, the contracting driller, was as follows:

Record of Vi-Clay No. 1 Well.

		Feet.	*Feet.*
1.	Surface soil, clay and gravel	15	15
2.	Sand rock	75	90
3.	Shale	5	95
4.	Coal	5	100
5.	Black to bluish shale	50	150
6.	Fire-clay	5	155
7.	Light grayish shale	145	200
8.	Light sand rock	100	300
9.	Light shale	200	500
10.	Dark slate	75	575
11.	Light sand	35	610
12.	Gray limestone	400	1010
13.	Gray limestone shells and dark shale	390	1400
14.	Light shale	65	1465
15.	Black shale	133	1598
16.	Gray limestone (oil bearing)	22+	....
	Total depth	...	1618

The iron used was as follows:

	Feet.
Drive pipe, 10 inch	15
Casing, 8 inch	707
Casing, 6⅝ inch	1405

More 8-inch casing was used than is necessary, as no water of consequence was found between the fire-clay, No. 6, which caved badly, and a point near the bottom of the limestone shells, No. 13. At the latter point were 10 or 12 feet of sharp grained limestone containing a quantity of briny water. This was shut off with the 6⅝-inch casing.

The black shale No. 15 is without doubt the Genesee or New Albany shale which immediately overlies the Corniferous or oil-bearing limestone. The top of the latter is said to be very hard and close-grained. The first oil was found 11 feet after striking it, and the porous or productive stratum was drilled in but six or seven feet before shooting. Upon being shot, about November 15, the well yielded 132 barrels the first day. It was pumped only at intervals, to December 27th, when it had filled three 250-barrel tanks. At that date it was said to be yielding at the rate of 50 barrels in 12 hours. A pipe line was then being constructed to the siding at Riley, where a loading rack was being built. No gas was found above the oil, and the only gas in the bore is that arising from the oil.

It is estimated by Mr. Scott that 40 to 50 days will be required to complete the average well in the vicinity. Coal for drilling and pumping can be had in quantity from nearby mines for about $2.10 per ton delivered.

The oil is a very blackish, very ill-smelling liquid, similar to that of the Phoenix well, the analysis and constituents of which are given on another page.

The usual excitement fostered by a new strike in wildcat territory followed the successful shooting of the well. Oil men from everywhere flocked to the vicinity and leases were taken on hundreds of farms within a radius of 20 miles. The Vi-Clay Company was offered $100,000 for their holdings, but refused that price, and let the contract for a second well. This, with six others, was soon located, and the timbers for their derricks were being hauled in on January 1st, 1907.

Elevations in Vigo County.—The following table of elevations in Vigo County was compiled by Dr. J. T. Scovell. They are mainly taken from railway levels and are adjustable to the level of the rail at the Union Station at Terre Haute, near the center of section 22-12-9. This point, as given by Gannett, is 485 feet above tide.

Table of Elevations in Vigo County.

	Feet above tide.
Rail at the Union Station (Gannett)	485
Ellsworth, on the Logansport road	492
Atherton, on the north county line	523
Hill one-half mile east of Atherton	625
Rosedale, one mile north of county line	537
Grant, on Big Four railroad	516
Fontanet, Nevins Township	539
Coal Bluff, on Otter Creek	553

	Feet above tide.
Lodi, on the county line	564
Perth, on the plateau in Clay County	633
Point one mile west of Seelyville	596
Seelyville Station	585
A point one mile east of Seelyville	604
East county line on the Vandalia	583
Spring Hill Junction, west of center of section 11-11-9	516
Honey Creek bridge, northeast northwest 17-11-8	505
Lockport or Riley Station	569
Highlands east of Lockport	622
County line, on the E. & I. Railway	614
Honey Creek bridge, on the Evansville road	509
Youngstown Station	578
Albin's hill, beyond Youngstown	604
Hartford or Pimento	600
County line on Evansville road	575
Farmersburg, one-half mile south of line	573
The west county line on the Vandalia	544
Point one mile west, on the plateau	581
Station at St. Mary's	555
Sandford, on the county line west	625
Morainic Hills, near Sandford	655
Yaw's Hill, northeast quarter section 18-10-8	673
Crapo's Hill, northwest quarter section 20-10-8	663

Properties of Terre Haute Oil.—The oil from the Corniferous at Terre Haute is darker colored, more ill-smelling and of a greater weight and density than the Trenton rock oil from the main Indiana field. An examination and comparison of samples of the two were made by Dr. Noyes, who reported on them as follows:*

	Terre Haute.				Van Buren.			
	Per Cent.	Specific Gravity.	Degrees Beaumé.	Flashing Point.	Per Cent...	Specific Gravity.	Degrees Beaumé.	Flashing Point.
Original oil	.....	0.879	30°	.....	.....	0.853	35°	.....
Below 150° C	.....	.....	.....	.....	7.2	0.719	.....	Below 20° C
150°–200° C	12.0	0.793	48°	38° C	10.2	0.759	56°	Below 20° C
200°–250° C	14.0	0.825	41°	65° C	10.2	0.799	47°	60° C
250°–300° C	13.6	0.847	36.5°	85° C	12.2	0.826	41°	82° C
300°–350° C	14.8	0.867	32.5°	97° C	14.8	0.844	37°	96° C
350°–390° C	40.6	0.879	30°	45° C	41.8	0.860	34°	38° C
Total distillate	95.0	.....	.....	.....	96.4	.....	.....	.....
Residue by weight	6.2 per cent.				4.5 per cent.			
Sulphur	.72 per cent.				.83 per cent.			

*The sample of Terre Haute oil was from the Phoenix well; that of Trenton rock oil was obtained at Van Buren, Grant County.

"The oils were distilled rather slowly from flasks with the thermometer in the vapor only. A thermometer filled with nitrogen and graduated to 460° C. was used.

"The oils appear to be quite similar in general character, but there is less of the low boiling products in the Terre Haute oil, and the specific gravity of the oil and of the various distillates is higher. The portion of the Terre Haute oil boiling at 350°-390° deposits considerable amounts of solid paraffines at 15° C. The low flashing point of the high boiling oil must be due to a partial 'cracking' of the oil. From the results, I calculate the following percentage of naphtha and kerosene contained in the petroleums:

	Terre Haute.	Van Buren.
Naphtha below specific gravity 0.73	None.	10%
Kerosene between specific gravity 0.73-0.83	30%	33%

There is little doubt but that a large quantity of oil occurs in the Corniferous limestone rocks beneath the city of Terre Haute and vicinity, else the yield of the Phoenix well could not have been so long continued. The porous area or reservoir containing the oil must, however, be narrow below that well, and this bore probably struck it at just the right point to get the best results. Some people who know little or nothing of the geology of Indiana believe that the Phoenix well struck a crevice, which extends to the main oil field of the State. Such belief is, of course, preposterous, as the Corniferous rock which contains the oil at Terre Haute outcrops before the main oil field is reached and is not pierced by any bore sunk in that field. Moreover, the Corniferous is a younger and much thinner formation than the Trenton limestone, and for that reason there is little chance of developing an oil output near Terre Haute in any way comparing to that of the main Indiana field. Until additional wells are completed in the vicinity of the one at Riley, no one can say what the future of that territory will be.

Jasper County Field.—In the Jasper County field the Corniferous or oil bearing limestone is found from 100 to 115 feet below the surface. On account of this shallow depth the output is small in quantity and heavy in quality, being a bluish or very dark green lubricating oil. The usual formation encountered in drilling a Jasper County well is as follows: Drift, consisting of sand,

clay and loam, 50 feet, under which is encountered a bed, 45 to 55 feet in thickness, of close-grained black shale which forms an impervious cover for the Corniferous limestone reservoir. This black shale or slate does not cave in drilling, it thus being necessary to use but a short length of drive pipe to shut off the drift formation. The operators use for this purpose 5⅝-inch casing and by driving it a sufficient distance into the black shale shut off the surface water. With the usual form of portable drilling machine employed in the Jasper County district, an expert crew has completed a bore in the remarkably short time of 23 hours' actual drilling time, it thus being evident that the cost of a well is a very small sum.

An analysis of a sample of the Jasper County oil, made by Mariner & Hoskins, of Chicago, gave the following results:

Analysis of Crude Petroleum from the Jasper County Oil Field.

Specific gravity	0.928 or 20.8° Beaumé
Cold test	7° F.
Flashing point	410° F.
Fire test	437° F.
Sulphur	1.26 per cent.
Asphaltic matter	2.90 per cent.

The oil was formerly refined by the Indian Asphalt Company, at Asphaltum, Jasper County. Its physical and chemical properties as derived from "actual runs made at the refinery upon a large scale" were as follows:

"Distillation started at 248° F. Thirty-eight gravity oil, light yellow in color. The total amount of distillates obtained when running the crude down to asphalt were 49 per cent. the loss was four per cent. and the amount of asphalt 47 per cent.

Average Gravity.	*Flash.*	*Fire.*	*Viscosity.*
26.2	272°	302°	170
25.4	292°	335°	210
24.8	312°	348°	310
24.0	338°	374°	728

"The viscosity of the crude at 90° F. is 1,274; gravity, 19.40 B.; at zero the crude will not flow through the viscosimeter, although its chill point cannot be obtained accurately, as there is no paraffine in it."

The output of the Jasper County field in 1904 was but 9,000 barrels and it has fallen off very much in the last two years, so

that at present it is hardly to be considered when treating of the oil industry of the State.

Washington County.—Four bores are reported to have been sunk to the Corniferous limestone near Salem, Washington County, during the year. Two of these came in dry and the others started at about three barrels each, and are not now being pumped. No data is at hand regarding their field records.

Developments in the Vicinity of Birdseye.—During the autumn of 1902 and the spring and summer of 1903 a number of bores were sunk for oil in the vicinity of Birdseye, a town in the southeastern corner of Dubois County. In some of the bores quite a quantity of oil was developed in the Corniferous limestone, but the wells were sunk too far apart, one from another, to pump with profit. As a consequence the field, as yet, counts for nothing in the petroleum industry of the State.

In the vicinity of Birdseye the average bore strikes the porous rock containing the oil at 980 to 1,010 feet below the surface. This rock is a bluish gray limestone, coarsely crystalline in structure. Pieces from the Kitterman well contain a number of small globular cavities, partially filled with crystals of calcite. The oil bearing stratum is usually found 10 to 15 feet below the top of the bed of limestone in which it occurs. Immediately overlying the latter is a bed of soft, black to brown shale, 10 to 40 feet in thickness. There is no doubt but that the latter is the Genesee shale which, as above mentioned, overlies the Corniferous in the western two-thirds of the State. The limestone containing the pay streak differs in color and structure from the Trenton, and also effervesces more freely. It is without doubt the Corniferous limestone, the samples being identical in structure and color with the outcrops of Corniferous in Clark County.

Fourteen bores were sunk in the Birdseye field, seven of which came in as light to fair producers, three as dry holes, one as a gas well and three with a small showing of oil. If the seven producers, or even three or four of them, had been put down close enough together to connect with one power, there is little doubt but that they would have produced a large quantity of oil. Being most of them several miles apart, and with no pipe line in the field it would not pay to pump them with separate power. It never pays, when one has a fair well completed, to go a mile or two away in search of a gusher. As it was, $50,000 or more was sunk by the three companies in the field, and not a dollar's worth of oil was sold.

The oil produced in the Birdseye field was examined by the chemist of the St. Louis Sampling and Testing works, who reported on it as follows:

"Composition of Crude Oil from Birdseye, Indiana.

	Per cent.
Light oils below 150° C	17.4
Illuminating oil between 150° and 300°	26.9
Lubricating oil above 300° C	42.2
Residuum	13.3

"Began to distill at about 45° C. Ceased to distill at about 350° C. Specific gravity, 0.850 at 16° C.

"The analysis shows it to be a very good grade of petroleum for the manufacture of light oils (naphtha, gasoline, etc.), and illuminating oil. The percentage of light oils being 17.4 per cent. and of illuminating oil 26.9 per cent., and with the method now employed of destructive distillation or 'cracking,' the percentage of illuminating oil would be largely increased to upwards of 60 per cent., but at the expense of much of the lubricating oil. The residuum, amounting to 13.3 per cent., consists mainly of coke."

HURON SANDSTONE PETROLEUM.

Petroleum from the Huron sandstone is now produced in Indiana only in the vicinity of Princeton, Gibson County. A number of wells producing oil from this formation were pumped from 1900 to 1904 near Loogootee, Martin County, but all have been abandoned. A detailed description of the Princeton field, with accompanying map, is given in the next paper.

At Loogootee the records of the producing wells showed:

	Feet.
Drive pipe	15 to 20
Casing	480
Top of oil sand	473 to 524
Total depth	485 to 543

The results show that in this region the productive stratum is not to be relied upon. The pay streak in which the oil occurs is a fine to coarse-grained drab colored sandstone, varying in thickness from three to 14 feet. It does not appear to be continuous, but is in pockets. It varies much in closeness of texture, in some places being soft, quite porous and productive; in others hard, close-grained and barren.

TEST OR WILDCAT BORES IN WESTERN AND SOUTHERN INDIANA.

Within the past few years a number of wildcat test bores have been sunk in western and southern Indiana, all of which came in dry or as salt water producers. Those which have come to the notice of the writer were located as follows: One near Cates, Fountain County; one two miles south of Dana, Vermillion County; three near Fairbanks, Sullivan County;* one near Owensburgh, Greene County; one three miles northeast of Vincennes, Knox County; one near Bridgeport, Marion County; one near Mont Clair, Hendricks County; one near Georgetown, Brown County; one near Vevay, Switzerland County; and two near Cannelton, Perry County.

In the Brown County well the top of Trenton is said to have been struck at 1,420 feet, and that formation was penetrated 440 feet without finding a trace of oil and but a slight quantity of gas. At a depth of 1,860 feet the well was abandoned.

In the well located on the land of John Bradford, one and a half miles northwest of Bridgeport, Marion County, the strata passed through are said to have been as follows:

Record of Well near Bridgeport, Marion County.

		Feet.
1.	Drift (clay and gravel)	170
2.	Soapstone (Knobstone shale)	85
3.	Black and brown Genesee shale	125
4.	Corniferous limestone	140
5.	Niagara shale	50
6.	Niagara limestone	100
	Total depth	670

This bore was stopped before any possible oil bearing stratum except the Corniferous limestone was reached.

In the bore near Vincennes the drill reached a depth of 1,860 feet without finding either oil or gas. At this depth a bad cave was encountered in a shale, and the bore was abandoned. Its record, as furnished by T. H. Adams, of Vincennes, was as follows:

*One of these is said to have produced three barrels of oil the first day from a depth of 475 feet.

Record of Bore Northeast of Vincennes.

		Feet.	Feet.
1.	Drive pipe to bed rock	45	45
2.	Yellow sandstone	35	80
3.	Slate and shale	115	195
4.	Sandstone, limestone and shale	140	335
5.	Coal, 5-foot vein	5	340
6.	Blue limestone	10	350
7.	Light shale	10	360
8.	Soapstone	30	390
9.	Limestone	35	425
10.	Light shale	10	435
11.	Sandstone	30	465
12.	Slate and shale	20	485
13.	Fire-clay	20	505
14.	Blue shale	15	520
15.	Limestone	5	525
16.	Blue slate	20	545
17.	Black shale	20	565
18.	Sandstone	15	580
19.	Soapstone	10	590
20.	Slate	35	625
21.	Limestone and slate	15	640
22.	White sandstone and salt water	30	670
23.	Slate and shale	30	700
24.	Blue limestone	2	702
25.	Soapstone and shale	83	785
26.	White sandstone and salt water	15	800
27.	Sandstone	15	815
28.	Sandstone and shale alternately	125	940
29.	Limestone	10	950
30.	Black slate	30	980
31.	Sandstone	20	1000
32.	Slate	20	1020
33.	Streaks of slate and limestone	110	1130
34.	Sandstone	50	1180
35.	Shale (cased)	20	1200
36.	Sandstone	93	1293
37.	Shale	5	1298
38.	Gray limestone	12	1310
39.	Shale	3	1315
40.	Soapstone	10	1325
41.	Shale	10	1335
42.	Blue limestone	5	1340
43.	White sandstone	25	1365
44.	Shale	10	1375
45.	Blue limestone	10	1385
46.	Slate	15	1400
47.	Red rock	10	1410

		Feet.	Feet.
48.	Sandstone and salt water	20	1430
49.	Shale (cased)	105	1535
50.	Gray limestone	120	1655
51.	Shale	5	1660
52.	Blue limestone	5	1665
53.	Slate and shale	25	1690
54.	Sandstone and sulphur water	50	1740
55.	Slate	10	1750
56.	Shale	5	1755
57.	Gray limestone	10	1765
58.	Shale and gray limestone	55	1820
59.	Red rock	5	1825
60.	Hard gray limestone	15	1840
61.	Soapstone	5	1845
62.	Gray limestone	5	1850
63.	Soapstone	10+	1860

A record of the well located two miles east of Vevay, Switzerland County, was furnished by P. D. Pleasants, as follows:

Record of Bore near Vevay.

		Feet.	Feet.
1.	Surface, soil and clay	60	60
2.	Limestone shell and shale, 6 inches thick, alternating	105	165
3.	Limestone	75	240
4.	Layers of shale and limestone 5 feet thick, alternating	60	300
5.	Dark, hard limestone	22	322
6.	Shale, soft	1	323
7.	Limestone, very hard and full of salt water	32	355

At a depth of 165 feet shale, gas and water were encountered. In No. 4 of the section, signs of gas and oil were abundant. "A bushel of the stuff brought out by the bailer looked like yeast working." Salt water was struck at 300 feet, and at 355 feet was standing within 50 feet of the top.

One of the bores located five miles northeast of Cannelton, Perry County, was drilled to a depth of 2,533 feet. The record of the strata passed through, furnished by Wm. G. Ford, was as follows:

Record of Bore Northeast of Cannelton, Perry County.

		Feet.	Feet.
1.	Soil and loose material	47	47
2.	Shale	110	157
3.	White sandstone	63	220
4.	Shale	9	229

		Feet.	Feet.
5.	Limestone	41	270
6.	Shale	5	275
7.	Limestone, white, hard	55	330
8.	Shale	16	346
9.	Limestone with red particles	6	352
10.	White sandstone	5	357
11.	Shale	3	360
12.	Sandstone	13	373
13.	Shale	23	396
14.	Limestone, dark	10	406
15.	Gray shale	30	436
16.	Limestone, white	9	445
17.	Shale, gray	15	460
18.	White sandstone, with a little salt water	20	480
19.	Sandstone, white	31	511
20.	Shale	7	518
21.	Limestone, hard and white, with streaks of gray shale	27	545
22.	Limestone, white	103	648
23.	Hard white limestone, with alternating white and dark streaks	88	736
24.	Dark and whitish limestone	108	844
25.	Light limestone with white specks	6	850
26.	Limestone with dark and light streaks	90	940
27.	Sandy shale, hard and dark	87	1027
28.	Limestone, dark brown	81	1108
29.	Limestone, reddish brown	22	1130
30.	Limestone, dark	150	1280
31.	Limestone, lighter	10	1290
32.	Limestone, dark	52	1342
33.	Limestone, gray speckled	93	1435
34.	Limestone, Niagara, fine gray	346	1781
35.	Shale, Utica, dark brown	119	1900
36.	Limestone, Trenton	633	2533

Salt water was encountered in several places in the bore. Six and a quarter inch casing was first put in to 395 feet. After the salt water was struck at 480 feet, the hole was reamed and casing sunk to 515 feet. Mineral water was struck at 634 feet. The hole was again reamed out and cased down to 648 feet. Salt water was found again at 733 feet, necessitating another reaming and lowering of the casing to 736 feet. A small amount of water was had at 774 feet (about 40 gallons per hour and diminishing), but not enough to interfere, the bailer taking care of it easily.

An analysis of the mineral water found in this well at 634 feet was made by Dr. J. N. Hurty, of Indianapolis, who reported on it as follows:

Analysis of Water from Well near Cannelton.

	Grains per U. S. Gallon.
Calcium carbonate ($CaCO_3$)	18.20
Calcium sulphate ($CaSO_4$)	22.66
Calcium chloride ($CaCl_2$)	130.20
Magnesium sulphate ($MgSo_4$)	147.37
Magnesium chloride ($MgCl_2$)	75.00
Sodium chloride (NaCl)	2681.03
Silica (SiO_2)	2.07
Hydrogen sulfid (H_2S)	Abundant

"This is a valuable medicinal water. It belongs to the class known as 'saline-sulphuretted waters.' It will be found cathartic and alterative. For bathing it is excellent. It will also act excellently in rheumatism, stomach troubles and like disorders."—*Hurty.*

One of the deepest wells drilled in Indiana was the one in the court house yard at Bloomington, Monroe County, which was put down about 1885 in search of artesian water. It was sunk to a depth of 2,730 feet and is said to have passed through the following formations without finding more than a trace of oil or gas:

General Record of Well at Bloomington.

	Feet.
Drift	6
Sub-carboniferous limestone	749
Devonian shales and limestones	170
Niagara limestone	240
Hudson River limestone	485
Utica shale	180
Trenton limestone	626
Potsdam sandstone	274
Total	2730

No oil or gas has been found in Indiana or adjoining states below the Trenton limestone, though a half dozen or more bores have passed entirely through that formation.

A bore was put down near the gas works on the east bank of the Wabash River at Terre Haute about 1890, which stopped at a depth of 2,940 feet. In it the top of Trenton was found at 2,890 feet. This was the deepest bore in western Indiana, and probably in the State.

* * *

Adding to the output of the Trenton rock petroleum fields that produced by the Corniferous limestone at Terre Haute and by the

Huron sandstone at Princeton, we find the total production and value of petroleum in Indiana for the last three years to be as follows:

Total Production and Value of Crude Petroleum Produced in Indiana in the Years 1904, 1905 and 1906.

	1904.		1905.		1906.	
	Barrels.	Value.	Barrels.	Value.	Barrels.	Value.
Trenton Rock Petroleum.	11,281,030	$12,127,107	10,892,438	$9,236,788	7,762,825	$6,877,863
Corniferous Rock Petroleum.....	18,103	21,040	12,064	13,270	7,269	8,456
Huron Rock Petroleum..	32,405	28,951	64,806	55,413	103,843	81,770
Total.....	11,331,538	$12,177,098	10,969,308	$9,305,473	7,873,937	$6,968,089

As one travels through the oil district of the State a sense of the greatness of the industry grows rapidly upon him. One might study it for years and yet not master its every intricacy. He finds a vast system of pumps, tubes and pipes drawing a stored liquid from the depths of the earth, and transporting it hundreds of miles to distant refineries, there to be separated into parts, each of which serves as a basis for articles of manifold kinds for the use of man. Depending upon this industry are several thousand men—rig-builders, drillers, tool dressers, pumpers, pipemen, gaugers, etc ; each class performing a special duty and all working in harmony for the advancement of the common industry. Yet the resource itself is seldom seen, except where it overflows in waste, even by the army of workmen who are engaged in its production.

In a study of such resources as coal, clay, building stone, etc., one can see the strata *in situ*, note their arrangement, measure their thickness and study in detail their relation to their surroundings; but in an area covered so deeply with drift as is the main oil field of Indiana, and where the resource in question is contained in a rock formation nowhere exposed to view in the State, the difficulties in the way of a proper presentation of the subject are many. The records of the formations passed through by the bores had to be obtained from drillers and operators, many of whom had little geological knowledge. Moreover, their records were scanty in detail, noting, as we have seen, little else than

the number of feet of drive pipe and casing used, the depth at which Trenton rock was found and the total depth of the bore. However, I found them at all times willing to place at my disposal such knowledge and records as they possessed, and to them I am indebted for such records as are included in the report.

To Messrs. George Davids and John Sidey, of Montpelier; W. H. Mandeville, W. A. Kunkle, R. K. Souder and Mike Long, of Bluffton; Jas. E. Hardison, of Geneva; Benjamin Fulton of Portland; H. C. Zeigler, H. A. Wheeler and Geo. E. Scott, of Muncie; B. A. Kinney, A. W. Nickle, A. S. Warren, R. B. Moran and L. A. Von Berin, of Marion, I am under special obligation for services rendered both in the field and since my return therefrom.